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IDENTIFIERS	DACUM Process

ABSTRACT

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 2-year vocational training program to prepare students for entry-level employment in computer-aided drafting and design in the machine tool industry. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with seven duties (and supporting technical workplace competencies): apply mathematical concepts; demonstrate fundamental drafting skills; plan and organize activities; prepare mechanical production drawings; assist engineering personnel; and use computer-aided drafting system. The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment with answer key. The handbook is arranged by duty grouping, with technical modules developed for each task box on the competency profile. The student laboratory manual contains a DACUM chart and learning modules.

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Each module in the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (KC)

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ED 422 485

Computer-Aided Drafting and Design Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor's Handbook
Student Laboratory Manual

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MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

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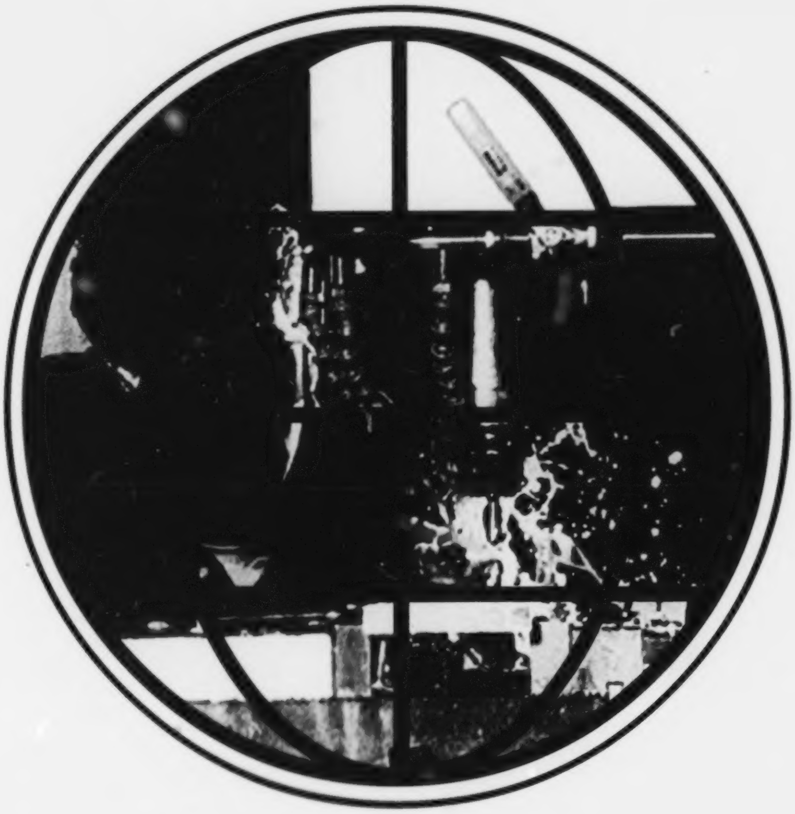
EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Computer-Aided Drafting & Design Series
COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

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EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY

Computer-Aided Drafting & Design Series

COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

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National Science Foundation
Advanced Technological
Education Program

"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

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This project was made possible by the cooperation and direct support of the following organizations:

National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS

Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, PALOS HILLS, IL
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Manufacturing in Moraine Valley

The metropolitan Chicago area, including northwestern Indiana, is among the most heavily industrialized areas of the United States. The neighboring Moraine Valley area is home to hundreds of the small- to medium-sized companies that supply the larger industrial concerns, including design, fabrication, metal-working and parts-assembly firms. The diversity of industry in the region and the continual need for qualified entry-level technicians and retraining of current workers has created a great demand for the development of industrial training and the services of Moraine Valley Community College and its Center for Contemporary Technology.

Moraine Valley Community College (MVCC) and the Center for Contemporary Technology (CTT)

Moraine Valley Community College (MVCC) is a public, postsecondary institution serving all or part of 26 communities in the southwest suburban area of Cook County, representing a population of more than 380,000. Located 25 miles southwest of downtown Chicago in Palos Hills, the college is the fourth largest community college in Illinois and serves a diverse student body drawn from the surrounding communities. The focal point for business and industry training in Moraine Valley is the 124,000 s.f. Center for Contemporary Technology (CTT). Opened in 1988, the Center is among the finest and most diverse advanced technology centers (ATC's) in the nation, with over $6 million of equipment and technology to provide training and education in Automated Manufacturing; Automotive Technology; Computer-Aided Design; Corrosion Mitigation; Electronics/Telecommunications; Environmental Control Technology; Information Management; Machining; Mechanical & Fluid Power Maintenance; Non-Destructive Evaluation; and Welding.

Development Team

- **Project Director**: Richard Hinckley, PhD., Dean of Instruction for Business and Industrial Technology and manager of the Center for Contemporary Technology, served as director for the MASTER project.
- **Subject Matter Expert**: Charles H. Bales, Instructor of Mechanical Design/Drafting, had program responsibility for developing skill standards and course/program materials for the mechanical design/drafting component of the MASTER project. Professor Bales also served as lead instructor for the MASTER pilot program in Computer-Aided Drafting and Design (CADD) Technician.
- **Skills Validation Coordinator**: Richard Kukac, MPA, Associate Dean of Instruction of Business and Industrial Technology, coordinated the industry skills verification process for MASTER and facilitated the industry validation sessions with teams of expert practitioners from the skill area.

Introduction

MASTER research indicates that individuals working as Computer-Aided Drafting and Design Technicians will preferably have received at least two years of training and education in both academic and technical courses in the areas of computer-aided drafting and design. This training may have been conducted in a vocational institution or college. Our research indicates that a minimum of two years of vocational training will prepare students with entry level skills necessary to begin work as a Manufacturing Technician.

In this two year program, the students progress through a series of courses designed to both educate and train students with knowledge and skills in areas such as technical mathematics, mechanical drafting, concepts of engineering design and analysis, and CAD skills. Students receive a wide range of training which enables them to seek jobs in many different manufacturing areas. The Computer-Aided Drafting and Design Program at Moraine Valley Community College has been training Computer-Aided Drafting and Design Technicians for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive Associate of Applied Science degrees from Moraine Valley. The Computer-Aided Drafting and Design Department worked closely with the MASTER staff, made every effort to assist the MASTER staff with research, and currently seek adoption of the recommended MASTER materials for their Computer-Aided Drafting and Design Department students. The Computer-Aided Drafting and Design Department at Moraine Valley is recognized throughout Illinois by large and small manufacturing companies as a premier source for entry-level technicians. Upon graduation, students are able to interpret complex drawings, select the correct materials, and perform all necessary drafting processes. The curriculum has been designed to prepare students to enter the workforce as entry-level Computer-Aided Drafting and Design Technicians. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries. The Computer-Aided Drafting and Design Department has a unique blend of theoretical knowledge and practical application which directly corresponds to modern uses in manufacturing.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine-related occupations (specifically computer-aided drafting and design technology), the **MASTER** Consortium Partners have agreed to present our definition of a computer-aided drafting and design technician as follows:

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN - plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become computer-aided drafting and design technicians.

The first and most important task of the **MASTER** program was the development of a foundation upon which all other works could be built. The **MASTER** Competency Profile is this foundation.

The MASTER Competency Profile

Development of Competency Profiles at each of the **MASTER** sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, the **MASTER** staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document over which they could claim ownership. This, in effect, made them real partners in the work of **MASTER**.

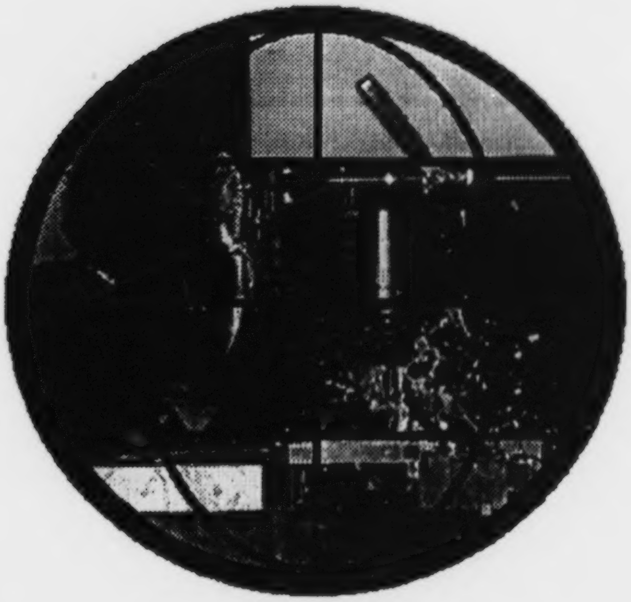
Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Computer-Aided Drafting and Design, as shown on the following page.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The **MASTER** Competency Profile for Computer-Aided Drafting & Design Technician has been included on the following page.

Computer-Aided Drafting and Design Technician

Competency Profile



Job Analysis conducted and prepared by

MASTER

***M**achine Tool **A**dvanced **S**kills*
***T**echnology **E**ducational*
***R**esources Program*
Consortium

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
A Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system
	A-5 Use the polar coordinate system			
B Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats
	B-5 Create technical sketches			
C Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents	
D Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering
	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings
	D-9 Perform drawing revisions	D-10 Use commercial and vendor data		
E Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
E **Assist Engineering Personnel** **(continued)**	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications	
F **Use Computer-Aided Drafting System**	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file
	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splines, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/ display commands
	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings
	F-13 Create 3D mechanical models	F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features
	F-17 Perform CAD customization procedures			

Computer-Aided Drafting & Design Technician

Skills, Traits, and Trends

Skills and Knowledge

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

Tool/Equipment Proficiency

Computer
CAD software
Printer
Plotter

Traits and Attitudes

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Consciousness
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

Current Trends

Adaptive Controls
Composites
In-Process Gauging
Conversational Programming
Artificial Intelligence
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing

The MASTER Pilot Program
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each MASTER partner reviewed its existing curriculum against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MASTER grant proposal:

> ***Pilot Program***: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."
>
> ***Student Assessment***: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry-level and already-employed technicians."
>
> (*Note*: Not all occupational specialty areas were pilot-tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.

MASTER Curriculum
Computer-Aided Drafting & Design
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
ENGL 101	Composition I	3	0	3
CAD 100	Introduction to Computer Graphics	0	4	2
CAD 101	Introduction to Drafting	3	4	4
MATH 135	Technical Mathematics	5	0	5
MTO 101	Introduction to Machine Tools	2	2	4
		13	10	18
Second Semester*				
CAD 110	Mechanical Detailing	2	3	3
CAD 145	Introduction to Computer-Aided Drafting	1	4	3
CAD 238	Drafting Seminar	1	0	1
CAD 160	3-D Modeling and Rendering	2	3	3
MET 104	Materials of Industry	2	0	2
	General Education Requirement			3
		8	10	15
Third Semester*				
MDT 205	Machine Elements	1	4	3
CAD 220	Tool Drafting	1	4	3
MDT 209	Hydraulics and Pneumatics	2	1	2
MTH 142	Trigonometric Functions	2	0	2
PHY 150	Mechanics, Heat and Sound	3	3	4
	General Education Requirement			3
		9	12	17
Fourth Semester*				
MDT 255	Machine Design	2	3	3
MDT 210	Statics and Strength of Materials	1	4	3
CAD 213	Plant Engineering Drafting	1	4	3
CAD 270	CAD/CAM Concepts	1	4	3
ENGL 103	Speech Fundamentals	3	0	3
	General Education Requirement			3
		8	14	18
	Program Totals	35+	44+	68

*** Each Semester is 16 weeks in length**

MASTER Course Descriptions
Computer-Aided Drafting & Design

First Semester

ENGL 101	**Composition I** (3-0-3) Designed to teach clear and effective writing, with emphasis on organizational patterns, style, the research paper, and types of composition. The purpose of this course is to help students learn how to use writing to discover and clarify what they think, feel, or believe; to effectively communicate to others in expository and argumentative prose what they think, feel, or believe; to develop critical thinking skills of observation, analysis, synthesis, and evaluation; and to develop a coherent essay within a limited time frame. Prerequisite: Grade of "C" or better in ENGL 090, Paragraph and Theme Writing, or appropriate score on placement test.
CAD 100	**Introduction to Computer Graphics** (0-4-2) Explores some of the graphics capabilities of the personal computer. Students will be exposed to software that allows the creation of line drawings in addition to the creative possibilities of a paint program. The capabilities of a word processor to accomplish desktop publishing are examined. Also covered is the ability to turn data into professional-looking presentation graphics. A highlight of the course is a look at an animation program.
CAD 101	**Introduction to Drafting** (3-4-4) Presents theory, technical skills, industrial applications and practices of technical sketching, engineering lettering, selection and use of equipment, geometric construction, multiviews, and auxiliary views.
MATH 135	**Technical Mathematics** (5-0-5) Topics in algebra with physical applications. Recommended for students in the electronics, non-destructive evaluation and mechanical design programs. Prerequisite: two years of high school math, including algebra, and appropriate placement test score, or MATH 095, Beginning Algebra with Geometry, with a grade of "C" or better.
MTO 101	**Introduction to Machine Tools** (2-2-3) General introduction to machining as a foundation technology in manufacturing. Introduction to the theory and operation of drilling, milling, and turning machines. Introduction to speeds and feeds. Introduction to precision measurement.

Second Semester

CAD 110	**Mechanical Detailing** (2-3-3) Emphasizes the theory and development of mechanical drafting and geometric dimensioning and tolerancing as it is applied to industrial applications such as machine design and manufacturing techniques. Further develops technical skills and industrial applications in casting, forging, stamping,

machining drawings, size and geometric tolerancing. Industrial references are used as well as drafting room procedures, including revisions. Prerequisites: ENGL 101, Composition I, CAD 101, Introduction to Drafting, MATH 135, Technical Mathematics, MTO 101, Introduction to Machine Tools, or consent of instructor.

CAD 145 **Introduction to Computer-Aided Drafting** (1-4-3) Enhances the student's existing drafting skills. This is accomplished through the generation of two- and three- dimensional orthographic drawings, as well as pictorial techniques, in the CAD environment. Operating system commands, cursor manipulation, direct display interaction, geometry creation and manipulation, file storage and retrieval, entity manipulation such as rotation and mirroring, and the use of output devices such as printers and plotters are just a few of the hardware and software capabilities to be covered. Prerequisites: CAD 101, Introduction to Drafting, 15 hours in the Mechanical Design Drafting/CAD Program, or one year professional drafting experience. Corequisite: CAD 110, Mechanical Detailing.

CAD 238 **Drafting Seminar** (1-0-1) Discusses and addresses various problems encountered in the work place, including job searches, resumes and assessment of benefits and wage scales. Problems in dealing with subordinates, superiors, and equals and strategies for raises and promotions will be discussed in detail. Guest speakers will make presentations to explain selected fields within the drafting occupations.

CAD 160 **3-D Modeling & Rendering** (2-3-3) Covers the basics of 3-D wire frames, surface modeling, solids modeling, and rendering. Students learn the concepts and techniques required to construct 3-D objects. These include 3-D coordinates, spherical coordinates and surface and solids modeling. User coordinate systems and multiple view ports are also discussed. Students construct a variety of objects using these techniques. Objects are rendered to slides and hard copy. Prerequisites: ENGL 101, Composition I, CAD 101, Introduction to Drafting, MATH 135, Technical Mathematics, MTO 101, Introduction to Machine Tools, or consent of instructor. Corequisite: CAD 145, Introduction to Computer-Aided Drafting.

MET 104 **Materials of Industry** (2-0-2) Introduces types and uses of industrial materials. Three general classifications of materials (ferrous metals, nonferrous metals, and composites) are studied emphasizing manufacture, properties, and industrial applications.

Third Semester

MDT 205 **Machine Elements** (1-4-3) Machine elements and basic mechanisms are topics in this study. Gears, cams, bearings, splines, linkages and motion producing devices are specifically studied. Prerequisites: CAD

110, Mechanical Detailing, and CAD 145, Introduction to Computer-Aided Drafting. Corequisite: CAD 220, Tool Drafting.

CAD 220 **Tool Drafting** (1-4-3) Introduces die design, jig design, drawing theory, industrial applications, technical skills and typical practices in tool drawings. Prerequisite: CAD 110, Mechanical Detailing.

MDT 209 **Hydraulics and Pneumatics** (2-1-2) Introduces the basic theory and applications of hydraulic and pneumatic components and circuits. Special attention is given to the application and design use of hydraulics and pneumatics for power transmission and the control of industrial processes. Prerequisites: PHY 150, Mechanics, Heat and Sound, and MATH 135, Technical Mathematics. Corequisite: MDT 255, Machine Design.

MATH 142 **Trigonometric Functions** (2-0-2) Is a study of the trigonometric functions, inverse trigonometric functions and appropriate applications. The concepts that will prepare a student for calculus are emphasized. Prerequisites: three years of high school MATH, including advanced algebra, and appropriate placement test score, or MATH 135, Technical Mathematics, or MATH 141, College Algebra (Functions), or concurrent registration in MATH 141, College Algebra (Functions).

PHY 150 **Mechanics, Heat and Sound** (3-3-4) Is a general college physics course for liberal arts or science majors covers motion, momentum, work, power, energy, fields, heat and forces. Prerequisites: two years of high school algebra or MATH 101, Intermediate Algebra.

Fourth Semester

MDT 255 **Machine Design** (2-3-3) Covers the basics of machine design including the design process, types of machines and mechanisms, and the application of machine elements in the design. Computer-aided drafting and design applications are discussed and utilized. Prerequisites: CAD 145, Introduction to Computer-Aided Drafting, and MDT 205, Machine Elements. Corequisite: MDT 210, Statics and Strength of Materials.

MDT 210 **Statics and Strength of Materials** (1-4-3) Introduces statics and the study of internal stresses in machine members such as equilibrium calculations for loaded beams, columns, and machine structures, static and strengths analysis of bolted and riveted joints, and pressure vessels. Moments of inertia, center of gravity, and centroids are computed; static and kinetic friction are discussed. Standard reference tables are used throughout. Prerequisites: MDT 205, Machine Elements, MATH 142, Trigonometric Functions, and PHY 150, Mechanics, Heat and Sound.

CAD 213 **Plant Engineering Drafting** (1-4-3) Covers piping layouts, symbols and detailing; electrical drafting of wiring diagrams, welding drafting and structural detailing and materials. Prerequisites: CAD 145,

	Introduction to Computer-Aided Drafting, CAD 220, Tool Drafting, and MATH 135, Technical Mathematics.
CAD 270	**CAD/CAM Concepts** (1-4-3) Focuses on theory and concepts in the fundamentals of programming a CAD-based system to generate numerical control programs for production machinery. Creation of tool databases, machining curves and tool paths for lathes and mills are covered, as are tool and turret statements, machine characteristics, post processors and tape utilities. Machining of parts is not included in this fundamental course. Prerequisites: CAD 145, Introduction to Computer-Aided Drafting, CAD 160, 3-D Modeling and Rendering, or consent of instructor.
ENGL 103	**Speech Fundamentals** (3-0-3) Introduces basic oral communication principles and skills, challenges of cultural diversity and gender equity. Includes study and practice in public speaking and discussion, preparation and organization, and delivery techniques. This course satisfies the requirements of Public Act 87-581.

The MASTER Technical Workplace Competencies and Course Crosswalk

After development of appropriate curricula for the pilot programs, each MASTER college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry-level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks and the pilot curriculum for Computer-Aided Drafting & Design. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

EXIT PROFICIENCY LEVEL SCALE					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	Rarely	Routinely with Supervision	Routinely with Limited Supervision	Routinely Without Supervision	Initiates/ Improves/ Modifies and Supervises Others

Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry-level employees have been incorporated into the development of the course syllabi.

COMPUTER-AIDED DRAFTING & DESIGN TECHNICIAN

Technical Workplace Competencies and Course Crosswalk

	Intro. to Computer Graphics	Introduction to Drafting	Technical Mathematics	Intro. to Machine Tools	Mechanical Detailing	Intro. to CAD	3-D Modeling & Rendering	Materials of Industry	Machine Elements	Tool Drafting	Hydraulics and Pneumatics	Trigonometric Functions	Mechanics, Heat and Sound	Machine Design	Statics & Strength of Mat.	Plant Engineering Drafting	CAD/Cam Concepts				EXIT PROFICIENCY LEVEL
A. APPLY MATHEMATICAL CONCEPTS																					
A-1 Perform Basic Arithmetic Operations	R	R	I	R	R	R	R	R	R	R	R	R	R	R	R	R	R				4
A-2 Compute Unit Conversions	R	I	I	R	R	R	R	R	R	R	R	I	R	R	R	R	R				4
A-3 Perform Basic Trigonometric Operations			I	R					R			I	R	R	R						4
A-4 Use the Cartesian Coordinate System	R	I	I	R	R	R	R	R	R	R	R	I	R	R	R	R	R				4
A-5 Use the Polar Coordinate System	R	I	I	R	R	R	R	R	R	R	R	I	R	R	R	R	R				4
B. DEMONSTRATE FUNDAMENTAL DRAFTING SKILLS																					
B-1 Use Drawing Media and Related Drafting Materials	I	I			R	R	R		R	R				M		R	R				4
B-2 Use Measuring Scales		I		R	R					R				M		R	R				4
B-3 Identify Drafting LineStyles and Weights	I	I			R	R	R			R				M		R	R				4
B-4 Prepare Title Blocks and Other Drafting Forms		I			R	R	R		R	R				M		R	R				4
B-5 Create Technical Sketches		I			R	R	R		R	R				M		R	R				4
C. PLAN AND ORGANIZE ACTIVITIES																					
C-1 Determine Scope of Drafting Assignment	R	I			R	R	R		R	R				M		R	R				4
C-2 Select Appropriate Drafting Techniques for Drawings	R	I			R	R	R		R	R				M		R	R				4
C-3 Maintain Supporting Documents					I				R	R				R		R	R				2
D. PREPARE MECHANICAL PRODUCTION DRAWINGS																					
D-1 Understand and Apply Mechanical Drawing Methods		I		R	R	R	R		R	R				M		R	R				4
D-2 Create Detail Drawings					I				R	R				M			R				4
D-3 Create Assembly Drawings					I		I		R	R				M			R				4
D-4 Perform Technical Lettering		I			R				R	R				M		R	R				4
D-5 Create Bill of Materials/Parts List					I				R	R				M		R					4
D-6 Apply Dimensions and Notes		I			R				R	R				M		R					4
D-7 Apply Dimensional Limits and Tolerances					I				R	R				M		R					4
D-8 Apply Current Drafting Standards to Drawings		I			I				R	R				M		R					4
D-9 Perform Drawing Revisions					I				R	R				M		R					3
D-10 Use Commercial and Vendor Data		I			R				R	R				R		R					2

I-Introduced and Taught R=Repeated and Reinforced M=Mastered

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COMPUTER-AIDED DRAFTING & DESIGN TECHNICIAN

Technical Workplace Competencies and Course Crosswalk

	Intro. to Computer Graphics	Introduction to Drafting	Technical Mathematics	Intro. to Machine Tools	Mechanical Detailing	Intro. to CAD	3-D Modeling & Rendering	Materials of Industry	Machine Elements	Tool Drafting	Hydraulics and Pneumatics	Trigonometric Functions	Mechanics, Heat and Sound	Machine Design	Statics & Strength of Mat.	Plant Engineering Drafting	CAD/Cam Concepts				EXIT PROFICIENCY
E. ASSIST ENGINEERING PERSONNEL																					
E-1 Understand Basic Design Procedures														I							3
E-2 Utilize Fasteners for Mechanical Applications		I			R				R	R				R		R					3
E-3 Utilize Power Transmission Elements for Mechanical Applications									I					R							2
E-4 Utilize Bearings for Mechanical Applications									I					R							3
E-5 Understand Basic Manufacturing Methods				I	R			I	R					R			R				3
E-6 Utilize Brakes and Clutches for Mechanical Applications														I							3
E-7 Design Shafts for Use in Mechanical Applications														R	I						2
F. USE COMPUTER-AIDED DRAFTING SYSTEM																					
F-1 Start and Exit a Software Program	I	I			R	I	R		R	R						R	R				4
F-2 Demonstrate Proper File Management Techniques	I	I			R	I	R		R	R						R	R				4
F-3 Use Directory Structure	I	I			R	I	R		R	R						R	R				4
F-4 Open, Save, and Exit a Drawing File	I	I			R	I	R		R	R						R	R				4
F-5 Utilize Drawing Setup Procedures		I			R	I	R		R	R						R	R				4
F-6 Use Geometric Objects (e.g., lines, splines, circles, etc.)	I	I			R	I	R		R	R						R	R				4
F-7 Use Text for Drawing Annotation	I	I			R	I	R		R	R						R	R				4
F-8 Use Viewing/Display Commands	I	I			R	I	R		R	R						R	R				4
F-9 Control Object Properties	I	I			R	I	R		R	R						R	R				4
F-10 Understand Procedure to Print/Plot a Drawing	I	I			R	I	R		R	R						R	R				4
F-11 Use Standard Layering Techniques		I			R	I	R		R	R						R	R				4
F-12 Create Mechanical CAD Drawings		I			R	I	R		R	R						R	R				4
F-13 Create 3D Mechanical Models						I	I										R				4
F-14 Use Drawing Feature Attributes						I															4
F-15 Obtain 3D Model Property Data							I										R				4
F-16 Use CAD Dimensioning Features		I			R	I			R	R						R	R				4
F-17 Perform CAD Customization Procedures					R	I	I		R	R						R	R				4

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I-Introduced and Taught R=Repeated and Reinforced M=Mastered

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SCANS

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources: *Identifies, organizes, plans, and allocates resources*
Interpersonal: *Works with others*
Information: *Acquires and uses information*
Systems: *Understands complex inter-relationships*
Technology: *Works with a variety of technologies*

FOUNDATION SKILLS:

Basic Skills: *Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well*
Thinking Skills: *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*
Personal Qualities: *Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty*

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, **MASTER** asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. **MASTER** also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the **MASTER** staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. **MASTER** realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

MASTER Curriculum
Computer-Aided Drafting & Design
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
ENGL 101	Composition I	3	0	3
CAD 100	Introduction to Computer Graphics	0	4	2
CAD 101	Introduction to Drafting	3	4	4
MATH 135	Technical Mathematics	5	0	5
MTO 101	Introduction to Machine Tools	2	2	4
		13	10	18
Second Semester*				
CAD 110	Mechanical Detailing	2	3	3
CAD 145	Introduction to Computer-Aided Drafting	1	4	3
CAD 238	Drafting Seminar	1	0	1
CAD 160	3-D Modeling and Rendering	2	3	3
MET 104	Materials of Industry	2	0	2
	General Education Requirement	—	—	3
		8	10	15
Third Semester*				
MDT 205	Machine Elements	1	4	3
CAD 220	Tool Drafting	1	4	3
MDT 209	Hydraulics and Pneumatics	2	1	2
MATH 142	Trigonometric Functions	2	0	2
PHY 150	Mechanics, Heat and Sound	3	3	4
	General Education Requirement	—	—	3
		9	12	17
Fourth Semester*				
MDT 255	Machine Design	2	3	3
MDT 210	Statics and Strength of Materials	1	4	3
CAD 213	Plant Engineering Drafting	1	4	3
CAD 270	CAD/CAM Concepts	1	4	3
ENGL 103	Speech Fundamentals	3	0	3
	General Education Requirement	—	—	3
		8	14	18
	Program Totals	35+	44+	68

*** Each Semester is 16 weeks in length**

ENGL 101

MASTER PROGRAM

Composition I

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Designed to teach clear and effective writing, with emphasis on organizational patterns, style, the research paper, and types of composition. The purpose of this course is to help students learn how to use writing to discover and clarify what they think, feel, or believe; to effectively communicate to others in expository and argumentative prose what they think, feel, or believe; to develop critical thinking skills of observation, analysis, synthesis, and evaluation; and to develop a coherent essay within a limited time frame.

PREREQUISITES: **Paragraph and Theme Writing**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Use the essential steps in the writing process;
2. Critically evaluate the writing of others; and,
3. Employ the basic tools of scholarship.

REQUIRED COURSE MATERIALS:

Textbook: *Essays From Contemporary Culture,* by Katherine Anne Ackley, Latest Edition

Simon and Shuster Handbook for Writers, by Lynn Quitman Troyka, Latest Edition

College-level Dictionary

Supplies:

One 3.5 hard disk
A 100 page 8½ x 11 spiral notebook

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Course Orientation	
Writing Questionnaire	
Creating Exercises for Writing Autobiography	
First Draft of Writing Autobiography Due	
Introduction to Word Processing	
Introduction to Word Processing	
Revising the Writing Autobiography	
Final Copy of Writing Autobiography Due	
Conferences	
Conferences	
Conferences	
Reading Assignment	
Reading Assignment	
Reading Assignment	
Reading Assignment	
Reading Assignment	
Creating Exercises for Personal Narrative	
First Draft of Personal Narrative Due	
Revising Personal Narrative Essay	
Final Copy of Personal Narrative Essay Due	
Conferences	
Conferences	
Conferences	
Reading Assignment	
Reading Assignment	
Reading Assignment	
Reading Assignment	
Reading Assignment	
First Draft of Interpersonal Relationship Essay Due	
Revising Interpersonal Relationship Essay	
Final Copy of Interpersonal Relationship Essay Due	

Debate Essay
Debate Essay
Debate Essay
First Draft of Debate Essay Due
Revising the Debate Essay
Final Copy of Debate Essay Due
Research: Library
Research Paper Due
First Draft of Research Paper Due
Revising Research Paper
Final Copy of Research Paper Due
Final Exam

Total Lecture Hours 48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class

C. Information: Acquires and uses information
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
- 5. *Speaking: Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations
   - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   - g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

- 1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   - a. Demonstrates ability to objectively assess personal strengths and weaknesses
   - b. Demonstrates ability to set realistic short-term and long-term goals
   - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   - d. Demonstrates ability to identify potential pitfalls and take evasive actions
   - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   - g. Demonstrates maturity in taking responsibility for decisions
- 2. *Problem Solving: Recognizes problems and devises and implements plan of action*
   - a. Demonstrates ability to detect problem through observation, inquiry, or directive

    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity

    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

CAD 100

MASTER PROGRAM

Introduction to Computer Graphics

COURSE SYLLABUS

Total lecture hours: 0 **Total lab hours: 64** **Credit hours: 2**

COURSE DESCRIPTION:

Explores some of the graphics capabilities of the personal computer. Students will be exposed to software that allows the creation of line drawings in addition to the creative possibilities of a paint program. The capabilities of a word processor to accomplish desktop publishing are examined. Also covered is the ability to turn data into professional-looking presentation graphics. A highlight of the course is a look at an animation program.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities; and,
4. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: None

Supplies: 3.5 High Density diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LAB OUTLINE:

Lab Topics	Contact Hrs.
MS-DOS/Windows Overview	4
AutoCAD Release 13 (Windows Version)	12
Microsoft Office	12
a. PowerPoint	
b. Word	
Autodesk Animator	12
Harvard Graphics	12
Student Project Time	12
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. *Resources: Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives

3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

        g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
        a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    5. *Speaking: Organizes ideas and communicates orally*
        a. Demonstrates appropriate listening and speaking skills in personal conversations
        b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations
B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses

b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    - e. Demonstrates maturity to take responsibility for actions
    - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks

- b. Demonstrates ability to separate work and personal behaviors
- c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
- d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
- e. Demonstrates ability to accept and use constructive criticism
- f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - CAD-A1 through CAD-A2;
    - CAD-A4 through CAD-A5;
    - CAD-B1;
    - CAD-B3;
    - CAD-C1 through CAD-C2;
    - CAD-F1 through CAD-F4;
    - CAD-F6 through CAD-F9; and,
    - CAD-F11.

CAD 100
04/050688

CAD 101

MASTER PROGRAM

Introduction to Drafting

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 64** **Credit hours: 4**

COURSE DESCRIPTION:

Presents theory, technical skills, industrial applications, and practices of technical sketching, engineering lettering, selection and use of equipment, geometric construction, multiviews, and auxiliary views.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings;
5. Assist engineering personnel; and,
6. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: *Technical Drawing*, Goetsch, D.L., Nelson, J.A., Chalk, W.D., Delmar Publishers, Latest Edition

Workbook for Technical Drawing, Goetsch, D.L., Nelson, J.A., Chalk, W.D., Delmar Publishers, Latest Edition

Supplies: 3.5 High Density diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Introduction; begin CAD	3
Sketching; lettering; more CAD	3
Scales; more CAD	3
Geometric construction; finish CAD	3
Multi-view orthographic projection	6
Section views	6
Auxiliary views	4
Dimensioning	6
Fasteners	4
Pictorials	4
Final Projects	6
Total Lecture Hours	**48**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction; begin CAD	4
Sketching; lettering; more CAD	4
Scales; more CAD	4
Geometric construction; finish CAD	4
Multi-view orthographic projection	8
Section views	8
Auxiliary views	4
Dimensioning	8
Fasteners	4
Pictorials	4
Final Projects	12
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks

        3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - *1.* ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
        - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
        - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
        - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
    - *2.* ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
        - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
        - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
        - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
        - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
        - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

- c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

   - e. Demonstrates ability to initiate and effect solution
   - f. Demonstrates ability to take responsibility for outcomes
   - g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

- b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
- c. Demonstrates ability to formulate and follow personal schedules
- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   CAD-A1 through CAD-A2;
   CAD-A4 through CAD-A5;
   CAD-B1 through CAD-B5;
   CAD-C1 through CAD-C2;
   CAD-D1;
   CAD-D4;
   CAD-D6;
   CAD-D8;
   CAD-D10;
   CAD-E2;
   CAD-F1 through CAD-F12; and,
   CAD-F16.

MASTER PROGRAM

Technical Mathematics

COURSE SYLLABUS

Total lecture hours: 80 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Topics in algebra with physical applications. Recommended for students in the electronics, non-destructive evaluation and mechanical design programs.

PREREQUISITES: **Beginning Algebra with Geometry or 2 years high school math (grade of C or better)**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts; and,
2. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: *Technical Mathematics*, by John C. Peterson, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,

7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Real Number Systems: Sets, Exponents, Measurement, Scientific Notation, Roots and Radicals	5
Algebraic Concepts: Simplifying Expressions, First-Degree Equations, and Word Problems	10
Geometric Applications: Areas, Perimeters and Volume	5
Rectangular Coordinate System: Relations, Functions, and Functional Notation and Graphs	10
Systems of Equations: Matrices, Determinants, Cramer's Rule and World Problems	10
Similar Figures: Variation - Direct, Inverse and Joint	10
Factoring: Linear, Quadratic and Cubic	10
Fractional Equations and Extraneous Roots, Quadratic Equations and Quadratic Formula	10
Logarithm Function: Basic Properties and Principles, Inverse of Power Function	5
Imaginary and Complex Numbers	5
Total Lecture Hours	**80**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

- I. COMPETENCIES
  - *A. Resources: Identifies, organizes, plans, and allocates resources*
    - 1. Allocates time to complete assigned tasks on schedule
    - 2. Determines and allocates required materials and resources for meeting objectives
    - 3. Evaluates skills, performance, and quality of work and provides feedback
  - *B. Interpersonal: Works with others*
    - 1. Participates as a member of the team, contributing to group effort
    - 2. Provides individual assistance/direction to peers as requested
    - 3. Determines and meets expectations
    - 4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    - 5. Negotiates resources in order to accomplish objectives
    - 6. Works well with all members of the class
  - *C. Information: Acquires and uses information*
    - 1. Acquires and evaluates information
    - 2. Organizes and maintains information
    - 3. Interprets and communicates information
  - *D. Systems: Understands complex inter-relationships*
    - 1. Understands and works well with social, organizational, and technological systems
    - 2. Monitors and corrects performance of system during operation
    - 3. Recommends modifications to system to improve performance
  - *E. Technology: Works with a variety of technologies*
    - 1. Chooses relevant procedures, tools, and equipment
    - 2. Applies appropriate procedures and techniques to accomplish tasks
    - 3. Identifies or solves problems to maintain equipment

- II. FOUNDATION SKILLS
  - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - *1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

from text and supplemental materials on a level to facilitate productive independent and group study

   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices

        e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
        f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
        g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
        a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    5. *Speaking: Organizes ideas and communicates orally*
        a. Demonstrates appropriate listening and speaking skills in personal conversations
        b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. *Problem Solving: Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

        c. Demonstrates ability to visually discriminate in gross and fine imagery
        d. Demonstrates ability to visualize abstractly
        e. Demonstrates ability to apply visual imagery to applied tasks

    4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        a. Demonstrates mastery of basic reading, math, and language skills through application
        b. Demonstrates ability to translate abstract theory into practical application
        c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        d. Demonstrates knowledge of good study skills and learning habits

    5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        a. Demonstrates use of simple logic
        b. Demonstrates ability to distinguish relationships
        c. Demonstrates ability to determine and isolate factors in relationships
        d. Demonstrates and applies knowledge through practice
        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        c. Demonstrates ability to focus on task at hand and work to completion
        d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        e. Demonstrates maturity to take responsibility for actions

    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors

c. Takes full responsibility for personal actions

d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable

e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   CAD-A1 through CAD-A5.

MATH 135
04/030/98

MASTER PROGRAM

Introduction to Machine Tools

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 32** **Credit hours: 4**

COURSE DESCRIPTION:

Is a general introduction to machining as a foundation technology in manufacturing. Introduction to the theory and operation of drilling, milling, and turning machines. Introduction to speeds and feeds. Introduction to precision measurement.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Prepare mechanical production drawings; and,
4. Assist engineering personnel.

REQUIRED COURSE MATERIALS:

Textbook: *Machine Tool Practices,* Kibbe, Neely, and Meyer, Wiley Pub., Latest Edition

Machinery's Handbook, revised by Johnson, Latest Edition

Supplies:

1. A six (6) inch 4R graduation satin chrome finish rule
2. A 0-1" micrometer
3. A 6" vernier caliper
4. Safety shoes
5. An apron
6. Safety glasses
7. Side shields

METHODS OF INSTRUCTION:

Lecture:	Didactic presentations will include lectures and instructor demonstrations.
Laboratory:	Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

Schedule: Because of the individualized nature of the Introduction to Machine Tools program, no firm schedule will be followed.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Complete measuring exercises using a rule, micrometer and vernier caliper	4
Weld, anneal, and grind a bandsaw blade sample	4
Layout, cut, and file a drill gage according to print	4
Sharpen a drill & drill a test hole within tolerance	2
Perform a drilling and tapping exercise	5
Shape a lathe tool out of mild steel using a pedestal grinder	4
Turn a lathe center according to print	5
Perform a milling profile exercise	4
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Complete measuring exercises using a rule, micrometer and vernier caliper	4
Weld, anneal, and grind a bandsaw blade sample	4
Layout, cut, and file a drill gage according to print	4
Sharpen a drill & drill a test hole within tolerance	2

Perform a drilling and tapping exercise	5
Shape a lathe tool out of mild steel using a pedestal grinder	4
Turn a lathe center according to print	5
Perform a milling profile exercise	4
Total Lab Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - *A. Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - *B. Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C. Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D. Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

  a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
  b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
  c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
  d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
  e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

  a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
  b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

   c. Demonstrates ability to understand and perform multi-step computations

   d. Demonstrates ability to read, interpret, and use standard measuring devices

   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*

   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**

5. ***Speaking*****:** ***Organizes ideas and communicates orally***

a. **Demonstrates appropriate listening and speaking skills in personal conversations**

b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**

c. **Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation**

d. **Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes**

e. **Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups**

f. **Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations**

g. **Demonstrates ability to take responsibility for presentations**

B. **Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons**

1. ***Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative***

a. **Demonstrates ability to objectively assess personal strengths and weaknesses**

b. **Demonstrates ability to set realistic short-term and long-term goals**

c. **Demonstrates ability to recognize and distinguish between positive and negative alternatives**

d. **Demonstrates ability to identify potential pitfalls and take evasive actions**

e. **Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response**

f. **Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives**

g. **Demonstrates maturity in taking responsibility for decisions**

2. ***Problem Solving: Recognizes problems and devises and implements plan of action***

a. **Demonstrates ability to detect problem through observation, inquiry, or directive**

   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

        e. Recognizes that attitudes, skills, and practice are essential to productivity
        f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        c. Demonstrates ability to focus on task at hand and work to completion
        d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        e. Demonstrates maturity to take responsibility for actions
        f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        a. Presents a positive attitude toward tasks
        b. Demonstrates ability to separate work and personal behaviors
        c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
        e. Demonstrates ability to accept and use constructive criticism
        f. Accepts positive reinforcement in an appropriate manner
    3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
        a. Demonstrates appropriate and acceptable social behaviors in interactions
        b. Demonstrates ability to work cooperatively in individual, team, or group situations
        c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A5;
    CAD-B2;
    CAD-D1; and,
    CAD-E5.

MASTER Curriculum
Computer-Aided Drafting & Design
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
ENGL 101	Composition I	3	0	3
CAD 100	Introduction to Computer Graphics	0	4	2
CAD 101	Introduction to Drafting	3	4	4
MATH 135	Technical Mathematics	5	0	5
MTO 101	Introduction to Machine Tools	2	2	4
		13	10	18
Second Semester*				
CAD 110	Mechanical Detailing	2	3	3
CAD 145	Introduction to Computer-Aided Drafting	1	4	3
CAD 238	Drafting Seminar	1	0	1
CAD 160	3-D Modeling and Rendering	2	3	3
MET 104	Materials of Industry	2	0	2
	General Education Requirement	—	—	3
		8	10	15
Third Semester*				
MDT 205	Machine Elements	1	4	3
CAD 220	Tool Drafting	1	4	3
MDT 209	Hydraulics and Pneumatics	2	1	2
MATH 142	Trigonometric Functions	2	0	2
PHY 150	Mechanics, Heat and Sound	3	3	4
	General Education Requirement	—	—	3
		9	12	17
Fourth Semester*				
MDT 255	Machine Design	2	3	3
MDT 210	Statics and Strength of Materials	1	4	3
CAD 213	Plant Engineering Drafting	1	4	3
CAD 270	CAD/CAM Concepts	1	4	3
ENGL 103	Speech Fundamentals	3	0	3
	General Education Requirement	—	—	3
		8	14	18
	Program Totals	35+	44+	68

*** Each Semester is 16 weeks in length**

Second Semester

MASTER PROGRAM

Mechanical Detailing

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 48** **Credit hours: 3**

COURSE DESCRIPTION:

Emphasizes the theory and development of mechanical drafting and geometric dimensioning and tolerancing as it is applied to industrial applications such as machine design and manufacturing techniques. Further develops technical skills and industrial applications in casting, forging, stamping, machining drawings, size and geometric tolerancing. Industrial references are used as well as drafting room procedures, including revisions.

PREREQUISITES:

Introduction to Drafting;
Technical Mathematics;
Composition I;
Introduction to Machine Tools

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings;
5. Assist engineering personnel; and,
6. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: *Engineering Drawing and Design,* C. Jensen, J. D. Helsel, Glencoe/McGraw-Hill, Latest Edition

Supplies:
The assignments in this course require many hours of drafting. However, it is at the discretion of the student whether the drawings are completed manually or using CAD. If the student is drawing manually then there are drafting supplies and equipment which are needed and must be furnished by the student. The only equipment that is

supplied by the department is the drafting table (with mechanical drafting arm) and the copying machine. The following is a short list of the ***minimum*** items necessary.

45°-45°-90° triangle
30°-60°-90° triangle
metric scale
circle templates
compass
mechanical pencil
Mechanical Engineers scale
Civil Engineers scale
drafting leads (ex. 4H, 2H, HB, B, 2B)
lead sharpener
eraser
eraser pad
eraser shield
drafting tape
drafting paper: standard white paper, unlined, (8½" x 11")
graph paper, ¼" square grid (8½" x 11")
vellum (11" x 17") (B size) with or without title block

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Introduction; drafting review	2
Drafting review (continued)	2
Fits and allowances	4

Introduction to manufacturing / forming processes	2
Detail drawings	4
Casting drawings	3
Forging drawings	3
Sheet metal drawings	3
Welding drawings	3
Assembly drawings	3
Final Projects	3
Total Lecture Hours	**32**

LAB OUTLINE

Lab Topics	Contact Hrs.
Introduction; drafting review	3
Drafting review (continued)	3
Fits and allowances	6
Introduction to manufacturing / forming processes	3
Detail drawings	6
Casting drawings	3
Forging drawings	3
Sheet metal drawings	3
Welding drawings	3
Assembly drawings	3
Final Projects	12
Total Lab Hours	**48**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. Resources: Identifies, organizes, plans, and allocates resources
    1. Allocates time to complete assigned tasks on schedule

        2. Determines and allocates required materials and resources for meeting objectives
        3. Evaluates skills, performance, and quality of work and provides feedback
    B. *Interpersonal: Works with others*
        1. Participates as a member of the team, contributing to group effort
        2. Provides individual assistance/direction to peers as requested
        3. Determines and meets expectations
        4. Exercises leadership qualities to effectively communicate ideas and make decisions.
        5. Negotiates resources in order to accomplish objectives
        6. Works well with all members of the class
    C. *Information: Acquires and uses information*
        1. Acquires and evaluates information
        2. Organizes and maintains information
        3. Interprets and communicates information
    D. *Systems: Understands complex inter-relationships*
        1. Understands and works well with social, organizational, and technological systems
        2. Monitors and corrects performance of system during operation
        3. Recommends modifications to system to improve performance
    E. *Technology: Works with a variety of technologies*
        1. Chooses relevant procedures, tools, and equipment
        2. Applies appropriate procedures and techniques to accomplish tasks
        3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
    A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
        1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
            a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
            b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
            c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts,

diagrams, graphs, schematics, blueprints, flow charts, etc.)

   - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. Speaking: Organizes ideas and communicates orally

a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. Demonstrates ability to objectively assess personal strengths and weaknesses

    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
- *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
- *3.* ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks

  b. Demonstrates ability to separate work and personal behaviors
  c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
  d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
  e. Demonstrates ability to accept and use constructive criticism
  f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
  a. Demonstrates appropriate and acceptable social behaviors in interactions
  b. Demonstrates ability to work cooperatively in individual, team, or group situations
  c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
  d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
  a. Accepts personal strengths and weaknesses and uses the same for positive advancement
  b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
  c. Demonstrates ability to formulate and follow personal schedules
  d. Demonstrates ability to wisely use classroom time
  e. Demonstrates use of good study habits and skills
  f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
  a Knows and demonstrates ability to distinguish between positive and negative behaviors
  b. Demonstrates honesty and integrity in working with peers and supervisors
  c. Takes full responsibility for personal actions
  d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
  e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    - CAD-A1 through CAD-A2;
    - CAD-A4 through CAD-A5;
    - CAD-B1 through CAD-B5;
    - CAD-C1 through CAD-C3;
    - CAD-D1 through CAD-D10;
    - CAD-E2;
    - CAD-E5;
    - CAD-F1 through CAD-F12; and,
    - CAD-F16 through CAD-F17.
2. ***Technical Drawing,*** D. L. Goetsch, J. A. Nelson, W. S. Chalk, Delmar Publishers, Latest Edition
3. ***Technical Drawing,*** F. E. Giesecke, et al., Macmillan, Latest Edition
4. ***Machine Drafting and Design,*** R. H. Nickolaisen, Prentice-Hall, Latest Edition
5. ***Geometric Dimensioning & Tolerancing for Engineering & Manufacturing Technology,*** C. Jensen, Delmar, Latest Edition
6. ***Machinery's Handbook,*** E. Oberg, et al., Industrial Press, Inc., Latest Edition

CAD 110
04/030698

MASTER PROGRAM

Introduction to Computer-Aided Drafting

COURSE SYLLABUS

Total lecture hours: 16	**Total lab hours: 64**	**Credit hours: 3**

COURSE DESCRIPTION:

Enhances the student's existing drafting skills. This is accomplished through the generation of two- and three-dimensional orthographic drawings, as well as pictorial techniques, in the CAD environment. Operating system commands, cursor manipulation, direct display interaction, geometry creation and manipulation, file storage and retrieval, entity manipulation such as rotation and mirroring, and the use of output devices such as printers and plotters are just a few of the hardware and software capabilities to be covered.

PREREQUISITES:	**Introduction to Drafting; 15 hours in the Mechanical Design Drafting/CAD program, or one year professional drafting experience**
COREQUISITE:	**Mechanical Detailing**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings; and,
5. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook:	*Harnessing AutoCAD Release 13 for Windows*, T. A. Stellman, G. V. Kirshman, R. A. Rhea, Delmar Publishers, Inc., Latest Edition
Supplies:	3.5 High Density diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Overview of CAD, computers (hardware/software), networks, lab configuration	1
Introduction to CAD; basic drawing and editing (single-view drawings)	1
Construct and modify commands	1
Edit and view commands; printing (multi-view drawings)	1
Layers, Linotypes and colors	1
Blocks; hatching	1
Multi-view orthographic drawing	1
Dimensioning	2
Paper space/model space	1
Drawing set-up, guidelines and tips	1
Advanced topics	1
Final Projects	—
Total Lecture Hours	**12**

LAB OUTLINE

Lab Topics	Contact Hrs.
Overview of CAD, computers (hardware/software), networks, lab configuration	4
Introduction to CAD; basic drawing and editing	

(single-view drawings)	4
Construct and modify commands	4
Edit and view commands; printing (multi-view drawings)	4
Layers, Linotypes and colors	4
Blocks; hatching	4
Multi-view orthographic drawing	4
Dimensioning	8
Paper space/model space	6
Drawing set-up, guidelines and tips	6
Advanced topics	16
Final Projects	—
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives

    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
    2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

- a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
- b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
- c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
- d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
- e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations
    - d. Demonstrates ability to read, interpret, and use standard measuring devices
    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    - b. Demonstrates ability to hear, comprehend, and appropriately follow directions

- c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
- d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
- e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
- f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking*: *Organizes ideas and communicates orally*
    - a. Demonstrates appropriate listening and speaking skills in personal conversations
    - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    - g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills**: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. Demonstrates use of simple logic

b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships

d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions

f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks

b. Demonstrates ability to separate work and personal behaviors

c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors

d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism

f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2;
    CAD-A4 through CAD-A5;
    CAD-B1;
    CAD-B3 through CAD-B5;
    CAD-C1 through CAD-C2;

    CAD-D1;
    CAD-F1 through CAD-F14; and,
    CAD-F16 through CAD-F17.

2. *Technical Drawing* by Goesecke, et al., Latest Edition
3. *Engineering Drawing & Design* by Jensen, et al., Latest Edition
4. *Technical Drawing* by Goetsche, et al., Latest Edition

CAD 145
04/091097

CAD 238

MASTER PROGRAM

Drafting Seminar

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 0** **Credit hours: 1**

COURSE DESCRIPTION:

Discusses and addresses various problems encountered in the work place, including job searches, resumes and assessment of benefits and wage scales. Problems in dealing with subordinates, superiors, and equals and strategies for raises and promotions will be discussed in detail. Guest speakers will make presentations to explain selected fields within the drafting occupations.

PREREQUISITES: **24 Credit Hours in Degree Program**

COURSE OBJECTIVES:

After the successful completion of this course the student will be able to:

1. Participate in drafting occupations with correct concepts of professional responsibilities;
2. Relate occupational experiences to professional growth;
3. Understand and utilize supervisory techniques; and,
4. Utilize working conditions as fully as possible.

REQUIRED COURSE MATERIALS: **NONE**

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2 Apply theory to assignments;
3 Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;

6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE

Lecture Topics	Contact Hrs.
Mechanical Design/CAD Careers	2
Guest Speaker	1
Job Ads	2
Speaker	1
Job Descriptions	1
Guest Speaker	1
Professional Resumes	2
Guest Speaker	1
Working Conditions	2
Guest Speaker	1
Interoffice Relations	1
Guest Speaker	1
Total Lecture Hours	**15**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives
      3. Evaluates skills, performance, and quality of work and provides feedback
   B. ***Interpersonal:*** *Works with others*

        1. Participates as a member of the team, contributing to group effort
        2. Provides individual assistance/direction to peers as requested
        3. Determines and meets expectations
        4. Exercises leadership qualities to effectively communicate ideas and make decisions.
        5. Negotiates resources in order to accomplish objectives
        6. Works well with all members of the class
    - *C.* *Information: Acquires and uses information*
        1. Acquires and evaluates information
        2. Organizes and maintains information
        3. Interprets and communicates information
    - *D.* *Systems: Understands complex inter-relationships*
        1. Understands and works well with social, organizational, and technological systems
        2. Monitors and corrects performance of system during operation
        3. Recommends modifications to system to improve performance
    - *E.* *Technology: Works with a variety of technologies*
        1. Chooses relevant procedures, tools, and equipment
        2. Applies appropriate procedures and techniques to accomplish tasks
        3. Identifies or solves problems to maintain equipment

- II. FOUNDATION SKILLS
    - A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
        1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
            - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
            - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
            - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
            - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations
    - d. Demonstrates ability to read, interpret, and use standard measuring devices
    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

        - a. **Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery**
        - b. **Demonstrates ability to hear, comprehend, and appropriately follow directions**
        - c. **Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction**
        - d. **Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately**
        - e. **Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds**
        - f. **Demonstrates ability and maturity to seek and receive additional individualized instruction as needed**
    - ***5. Speaking: Organizes ideas and communicates orally***
        - a. **Demonstrates appropriate listening and speaking skills in personal conversations**
        - b. **Demonstrates ability to choose and organize appropriate words to effectively communicate**
        - c. **Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation**
        - d. **Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes**
        - e. **Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups**
        - f. **Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations**
        - g. **Demonstrates ability to take responsibility for presentations**
- **B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons**
    - ***1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative***
        - a. **Demonstrates ability to objectively assess personal strengths and weaknesses**
        - b. **Demonstrates ability to set realistic short-term and long-term goals**
        - c. **Demonstrates ability to recognize and distinguish between positive and negative alternatives**
        - d. **Demonstrates ability to identify potential pitfalls and take evasive actions**

    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application

        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - *5.* ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions
        - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
    - *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
        - a. Presents a positive attitude toward tasks
        - b. Demonstrates ability to separate work and personal behaviors
        - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
        - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

   - e. Demonstrates ability to accept and use constructive criticism
   - f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   - a. Demonstrates appropriate and acceptable social behaviors in interactions
   - b. Demonstrates ability to work cooperatively in individual, team, or group situations
   - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   - a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   - b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   - c. Demonstrates ability to formulate and follow personal schedules
   - d. Demonstrates ability to wisely use classroom time
   - e. Demonstrates use of good study habits and skills
   - f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   - b. Demonstrates honesty and integrity in working with peers and supervisors
   - c. Takes full responsibility for personal actions
   - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   - e. Demonstrates positive work and social ethics in undertakings

MASTER PROGRAM

3-D Modeling and Rendering

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 48** **Credit hours: 3**

COURSE DESCRIPTION:

Covers the basics of 3-D wireframes, surface modeling, solid modeling, and rendering. Students learn the concepts and techniques required to construct 3-D objects. These include 3-D coordinates, spherical coordinates, and surface and solids modeling. User coordinate systems and multiple viewports are also discussed. Students construct a variety of objects using these techniques. Objects are rendered to slides and hard copy.

PREREQUISITES:	**Composition I;** **Introduction to Drafting;** **Technical Mathematics;** **Introduction to Machine Tools**
COREQUISITE:	**Introduction to Computer-Aided Drafting**

COURSE OBJECTIVES:

Upon successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings; and,
5. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook:	***Modeling With AutoCAD Designer,*** Dobek, S., Ranschaert, R., Irwin, Latest Edition
Supplies:	3-4 High Density 3½" computer disks

METHODS OF INSTRUCTION:

Lecture:	Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topic	Contact Hrs.
Introduction and overview of computer software	1
File system management	1
3-D solid modeling concepts overview	2
a. Coordinate system entry methods	
b. Filtering	
3-D viewing	2
3-D solid modeling geometry construction	4
a. Extrusions	
b. Boolean Operations	
3-D solid modeling geometry construction	6
a. 3-D geometry editing	
3-D to 2-D conversion	4
a. Drawing layout	
b. Paper space/model space	
Constraints	2
a. Bi-directional associativity	
Surface modeling concepts	2
Surface modeling editing techniques	2
Rendering overview	4
a. Lights	
b. Cameras	
c. Shading	
d. Shadows	
Student project	2
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction and overview of computer software	1
File system management	1
3-D solid modeling concepts overview	2
a. Coordinate system entry methods	
b. Filtering	
3-D viewing	2
3-D solid modeling geometry construction	5
a. Extrusions	
b. Boolean Operations	
3-D solid modeling geometry construction	5
a. 3-D geometry editing	
3-D to 2-D conversion	5
a. Drawing layout	
b. Paper space/model space	
Constraints	2
a. Bi-directional associativity	
Surface modeling concepts	2
Surface modeling editing techniques	3
Rendering overview	5
a. Lights	
b. Cameras	
c. Shading	
d. Shadows	
Student project	15
Total Lab Hours	**48**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information

from text and supplemental materials on a level to facilitate productive independent and group study

- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations
    - d. Demonstrates ability to read, interpret, and use standard measuring devices

    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

  4. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

  5. Speaking: Organizes ideas and communicates orally
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate
    c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
    d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
    e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
    f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
    g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. *Problem Solving: Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1. Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
        - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
        - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
        - c. Demonstrates ability to focus on task at hand and work to completion
        - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
        - e. Demonstrates maturity to take responsibility for actions

    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors

c. **Takes full responsibility for personal actions**
d. **Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable**
e. **Demonstrates positive work and social ethics in undertakings**

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2;
    CAD-A4 through CAD-A5;
    CAD-B1;
    CAD-B3 through CAD-B5;
    CAD-C1 through CAD-C2;
    CAD-D1;
    CAD-D3;
    CAD-F1 through CAD-F13;
    CAD-F15; and,
    CAD-F17.

CAD 160
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MASTER PROGRAM

Materials of Industry

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 0** **Credit hours: 2**

COURSE DESCRIPTION:

Introduces types and uses of industrial materials. Three general classifications of materials (ferrous metals, nonferrous metals, and composites) are studied emphasizing manufacture, properties, and industrial applications.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Apply mathematical concepts;
2. Identify various types of materials;
3. Apply metals identification systems;
4. Assist engineering personnel; and,
5. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: *Fundamentals of Materials Science for Technologists,* Horath, Larry., Prentice Hall, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A students grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;

3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions; and,
6. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Atomic, crystal & grain structures	2
Ferrous metals	4
Heat treatment	2
Non-ferrous metals	4
Polymers and elastomers	4
Wood and wood products	2
Ceramics	4
Cement, concrete and asphalt	4
Composites	2
Adhesives and coatings	2
Fuels and lubricants	2
Total Lecture Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback

- *B.* *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
- *C.* *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
- *D.* *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
- *E.* *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    - *1.* *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
        - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
        - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
        - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

- d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
- e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    - c. Demonstrates ability to understand and perform multi-step computations
    - d. Demonstrates ability to read, interpret, and use standard measuring devices
    - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

        g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
        a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    5. ***Speaking***: *Organizes ideas and communicates orally*
        a. Demonstrates appropriate listening and speaking skills in personal conversations
        b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations
B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses

    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions

2. *Problem Solving: Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks

    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:** Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:** Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2;
    CAD-A4 through CAD-A5; and,
    CAD-E5.
2. *Practical Metallurgy and Materials of Industry,* Neely, John E., Prentice Hall, Latest Edition

MET 104
04/030888

MASTER Curriculum
Computer-Aided Drafting & Design
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
ENGL 101	Composition I	3	0	3
CAD 100	Introduction to Computer Graphics	0	4	2
CAD 101	Introduction to Drafting	3	4	4
MATH 135	Technical Mathematics	5	0	5
MTO 101	Introduction to Machine Tools	2	2	4
		13	10	18
Second Semester*				
CAD 110	Mechanical Detailing	2	3	3
CAD 145	Introduction to Computer-Aided Drafting	1	4	3
CAD 238	Drafting Seminar	1	0	1
CAD 160	3-D Modeling and Rendering	2	3	3
MET 104	Materials of Industry	2	0	2
	General Education Requirement	—	—	3
		8	10	15
Third Semester*				
MDT 205	Machine Elements	1	4	3
CAD 220	Tool Drafting	1	4	3
MDT 209	Hydraulics and Pneumatics	2	1	2
MATH 142	Trigonometric Functions	2	0	2
PHY 150	Mechanics, Heat and Sound	3	3	4
	General Education Requirement	—	—	3
		9	12	17
Fourth Semester*				
MDT 255	Machine Design	2	3	3
MDT 210	Statics and Strength of Materials	1	4	3
CAD 213	Plant Engineering Drafting	1	4	3
CAD 270	CAD/CAM Concepts	1	4	3
ENGL 103	Speech Fundamentals	3	0	3
	General Education Requirement	—	—	3
		8	14	18
	Program Totals	35+	44+	68

*** Each Semester is 16 weeks in length**

MDT 205

MASTER PROGRAM

Machine Elements

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Machine elements and basic mechanisms are topics in this study. Gears, cams, bearings, splines, linkages and motion-producing devices are specifically studied.

PREREQUISITES: **Mechanical Detailing;**
Introduction to Computer-Aided Drafting

COREQUISITE: **Tool Drafting**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings;
5. Assist engineering personnel; and,
6. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: *Engineering Drawing and Design,* Jensen, C., Helsel, J.D., Glencoe/McGraw-Hill, Latest Edition

Supplies: 2-3 High Density 3½" computer disk

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	**Contact Hrs.**
Gear trains	1
a. Gear calculations	1
b. Spur gears	1
c. Bevel gears	1
d. Worm gears	1
V-Belts and pulleys	1
Chain drive system	2
Cams	2
Bearings	2
Splines	2
Linkages and motion devices	2
Total Lecture Hours	**16**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
Gear calculations	12
Spur gear drawing	8
Bevel gear drawing	8
Worm gear drawing	4
V-belts and pulleys	4
Chain drive systems	4
Cam drawing	12
Bearings	4
Linkages and motion devices	8
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - *A. Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - *B. Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C. Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D. Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - *E. Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. **FOUNDATION SKILLS**

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  - *1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
  - *2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

- c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
- d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
- e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
- f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
- g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    - a. Demonstrates ability to objectively assess personal strengths and weaknesses
    - b. Demonstrates ability to set realistic short-term and long-term goals
    - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    - d. Demonstrates ability to identify potential pitfalls and take evasive actions
    - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    - g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    - a. Demonstrates ability to detect problem through observation, inquiry, or directive
    - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    - c. Demonstrates ability to generate alternatives or options for problem solution
    - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

- e. Demonstrates ability to initiate and effect solution
- f. Demonstrates ability to take responsibility for outcomes
- g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*

- a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

    b. **Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner**
    c. **Demonstrates ability to formulate and follow personal schedules**
    d. **Demonstrates ability to wisely use classroom time**
    e. **Demonstrates use of good study habits and skills**
    f. **Demonstrates maturity to take responsibility for own actions**

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. **Knows and demonstrates ability to distinguish between positive and negative behaviors**
    b. **Demonstrates honesty and integrity in working with peers and supervisors**
    c. **Takes full responsibility for personal actions**
    d. **Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable**
    e. **Demonstrates positive work and social ethics in undertakings**

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A5;
    CAD-B1;
    CAD-B4 through CAD-B5;
    CAD-C1 through CAD-C3;
    CAD-D1 through CAD-D10;
    CAD-E2 through CAD-E5;
    CAD-F1 through CAD-F12; and,
    CAD-F16 through CAD-F17.
2. ***W.S., Technical Drawing,*** Goetsch, D.L., Nelson, J.A., Chalk, Delmar Publishers, Latest Edition
3. ***Machinery's Handbook,*** Oberg, E., et al., Industrial Press, Inc., Latest Edition

CAD 220

MASTER PROGRAM

Tool Drafting

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Introduces die design, jig design, drawing theory, industrial applications, technical skills, and typical practices in tool drawings.

PREREQUISITES: None

COREQUISITE: Mechanical Detailing

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings;
5. Assist engineering personnel; and,
6. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: Instructor supplied handouts

Supplies: 3.5" high-density disks

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy, and;
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Punches	2
a. Shoulder	
b. Ball lock	
Punch Holder	2
a. Die block	
b. Clearance	
Pierce Die	4
Drill Bushings	1
Drill Jig No. 1	2
Drill Jig No. 2	2
Drill Jig No. 3	3
Total Lecture Hours	**16**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Punches	8
a. Shoulder	
b. Ball lock	
Punch Holder	8
a. Die block	
b. Clearance	
Pierce Die	16
Drill Bushings	4
Drill Jig No. 1	8
Drill Jig No. 2	8
Drill Jig No. 3	12
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. Resources: Identifies, organizes, plans, and allocates resources
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. Interpersonal: Works with others
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. Information: Acquires and uses information
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. Systems: Understands complex inter-relationships
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. Technology: Works with a variety of technologies
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking***: *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses
        b. Demonstrates ability to set realistic short-term and long-term goals
        c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        d. Demonstrates ability to identify potential pitfalls and take evasive actions
        e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        g. Demonstrates maturity in taking responsibility for decisions
    2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        a. Demonstrates ability to detect problem through observation, inquiry, or directive
        b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
        c. Demonstrates ability to generate alternatives or options for problem solution
        d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
a. Demonstrates mastery of basic reading, math, and language skills through application
b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*

    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty: Chooses ethical courses of action***
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   CAD-A1 through CAD-A2;
   CAD-A4 through CAD-A5;
   CAD-B1 through CAD-B5;
   CAD-C1 through CAD-C3;
   CAD-D1 through CAD-D10;
   CAD-E2;
   CAD-F1 through CAD-F12; and,
   CAD-F16 through CAD-F17.

MASTER PROGRAM

Hydraulics And Pneumatics

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 16** **Credit hours: 2**

COURSE DESCRIPTION:

Introduces the basic theory and applications of hydraulic and pneumatic components and circuits. Special attention is given to application and design use of hydraulics and pneumatics for power transmission and the control of industrial processes.

PREREQUISITES:	**Mechanics, Heat and Sound;** **Technical Mathematics**
COREQUISITE:	**Machine Design**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Employ basic hydraulic and pneumatic techniques for power transmission; and,
3. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbooks:	*Hydraulic Technology,* Parker, Bulletin 0221-B1 Ind., Latest Edition *Pneumatic Technology,* Parker, Bulletin 0275-B4 Ind., Latest Edition
Supplies:	None

METHODS OF INSTRUCTION:

Lecture:	Didactic presentations will include lectures and instructor demonstrations.
Laboratory:	Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Hydraulic Principles	2
Pump Theory	2
Motors	2
Actuators	2
Directional Controls	2
Pressure Controls	2
Flow Controls	2
Reservoirs, Coolers, Filters	2
Check Valves, Accumulators, Cylinders	2
Control Pneumatic Energy	2
Energy Transmission	2
Compressors	2
Aftercoolers	2
Regulators	3
Air Preparation	3
Total Lecture Hours	**48**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Hydraulic Principles	1
Pump Theory	6
Reservoirs, Coolers, Filters	3
Energy Transmission	2
Aftercoolers	2
Air Preparation	2
Total Lab Hours	**16**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1. **Decision Making:** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2. **Problem Solving:** Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive
        - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
        - c. Demonstrates ability to generate alternatives or options for problem solution
        - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

        - e. Demonstrates ability to initiate and effect solution
        - f. Demonstrates ability to take responsibility for outcomes
        - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    - 3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
        - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

- a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
- b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
- c. Demonstrates ability to focus on task at hand and work to completion
- d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
- e. Demonstrates maturity to take responsibility for actions
- f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    - a. Presents a positive attitude toward tasks
    - b. Demonstrates ability to separate work and personal behaviors
    - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    - e. Demonstrates ability to accept and use constructive criticism
    - f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    - a. Demonstrates appropriate and acceptable social behaviors in interactions
    - b. Demonstrates ability to work cooperatively in individual, team, or group situations
    - c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    - d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    - a. Accepts personal strengths and weaknesses and uses the same for positive advancement

- b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
- c. Demonstrates ability to formulate and follow personal schedules
- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2; and,
    CAD-A4 through CAD-A5.

MASTER PROGRAM

Trigonometric Functions

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 0** **Credit hours: 2**

COURSE DESCRIPTION:

This course is a study of the trigonometric functions, inverse trigonometric functions, and appropriate applications. The concepts that will prepare a student for calculus are emphasized.

PREREQUISITES: **College Algebra (Functions); Technical Mathematics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Apply mathematical concepts.

REQUIRED COURSE MATERIALS:

Textbook: *Technical Mathematics*, John C. Peterson, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform on written, oral, or practical examinations;
2. Perform on outside assignments, including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Real Number Systems: Sets, Exponents, Scientific Notation, Root and Radicals	3
Algebraic Concepts: Simplifying Expressions, First-Degree Equations, and Word Problems	3
Geometric Applications: Areas, Perimeters and Volume	3
Rectangular Coordinate System: Relations, Functions and Functional Notation and Graphs	3
Systems of Equations: Matrices, Determinants, Cramer's Rule and Word Problems	3
Similar Figures: Variation - Direct, Inverse and Joint	3
Factoring: Linear, Quadratic and Cubic	3
Fractional Equations and Extraneous Roots, Quadratic Equations and Quadratic Formula	3
Logarithm Function: Basic Properties and Principles, Inverse of Power Function	3
Imaginary and Complex Numbers	5
Total Lecture Hours	**32**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
   A. *Resources: Identifies, organizes, plans, and allocates resources*
      1. Allocates time to complete assigned tasks on schedule
      2. Determines and allocates required materials and resources for meeting objectives

    3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class

C. Information: Acquires and uses information

    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

- a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
- b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
- c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

        - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
    - 4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
        - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
        - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
        - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
        - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    - 5. *Speaking: Organizes ideas and communicates orally*
        - a. Demonstrates appropriate listening and speaking skills in personal conversations
        - b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        - c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations
- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - 1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses

   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks

    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   CAD-A1 through CAD-A5.

MATH 142
04/030698

PHY 150

MASTER PROGRAM

Mechanics, Heat, and Sound

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 48** **Credit hours: 4**

COURSE DESCRIPTION:

This general college physics course for liberal arts or science majors covers motion, momentum, work, power, energy, fields, heat, and forces.

PREREQUISITES: **Intermediate Algebra or**
2 Years High School Algebra

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Recognize mechanical forces; and,
3. Solve mechanical systems.

REQUIRED COURSE MATERIALS:

Textbook: *College Physics*, Serway & Faughn, Saunders Publishing, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;

2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction, Measurement, Units, Mathematics	3
Motion in One Dimension	6
Vectors and Two Dimensional Motion	3
The Laws of Motion	6
Work and Energy	6
Momentum and Collisions	3
Circular Motion and the Laws of Gravity	3
Rational Equilibrium and Rotational Dynamics	3
Solids and Fluids	3
Thermal Physics	6
Heat	3
Laws of Thermodynamics	3
Total Lecture Hours	48

LAB OUTLINE:

Lab Topics	Contact Hrs.
Metric Measurement, Trig Review, Density	3
Free Fall	3
Force Vectors	3
Projectile Motion	3
2nd Law	6
Horsepower	3
Ballistics Pendulum	3
Collisions	3
Rotational Dynamics	3
Torque	3
Archemede's Principle	3
Linear Expansion	6
Calorimetry	3
Review	3
Total Lab Hours	48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
      b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
      c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
      d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
      e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

    1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses
        b. Demonstrates ability to set realistic short-term and long-term goals
        c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        d. Demonstrates ability to identify potential pitfalls and take evasive actions
        e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        g. Demonstrates maturity in taking responsibility for decisions
    2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        a. Demonstrates ability to detect problem through observation, inquiry, or directive
        b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
        c. Demonstrates ability to generate alternatives or options for problem solution
        d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

    - e. Demonstrates ability to initiate and effect solution
    - f. Demonstrates ability to take responsibility for outcomes
    - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
  3. ***Seeing Things In the Mind's Eye:** Organizes, and processes symbols, pictures, graphs, objects, and other information*
    - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    - c. Demonstrates ability to visually discriminate in gross and fine imagery
    - d. Demonstrates ability to visualize abstractly
    - e. Demonstrates ability to apply visual imagery to applied tasks
  4. ***Knowing How to Learn:** Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
    - b. Demonstrates ability to translate abstract theory into practical application
    - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    - d. Demonstrates knowledge of good study skills and learning habits
  5. ***Reasoning:** Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    - a. Demonstrates use of simple logic
    - b. Demonstrates ability to distinguish relationships
    - c. Demonstrates ability to determine and isolate factors in relationships
    - d. Demonstrates and applies knowledge through practice
    - e. Recognizes that attitudes, skills, and practice are essential to productivity
    - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
  1. ***Responsibility:** Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A5.
2. ***Schaum's Outline in Physics,*** Latest Edition

MASTER Curriculum
Computer-Aided Drafting & Design
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
First Semester*				
ENGL 101	Composition I	3	0	3
CAD 100	Introduction to Computer Graphics	0	4	2
CAD 101	Introduction to Drafting	3	4	4
MATH 135	Technical Mathematics	5	0	5
MTO 101	Introduction to Machine Tools	2	2	4
		13	10	18
Second Semester*				
CAD 110	Mechanical Detailing	2	3	3
CAD 145	Introduction to Computer-Aided Drafting	1	4	3
CAD 238	Drafting Seminar	1	0	1
CAD 160	3-D Modeling and Rendering	2	3	3
MET 104	Materials of Industry	2	0	2
	General Education Requirement	—	—	3
		8	10	15
Third Semester*				
MDT 205	Machine Elements	1	4	3
CAD 220	Tool Drafting	1	4	3
MDT 209	Hydraulics and Pneumatics	2	1	2
MATH 142	Trigonometric Functions	2	0	2
PHY 150	Mechanics, Heat and Sound	3	3	4
	General Education Requirement	—	—	3
		9	12	17
Fourth Semester*				
MDT 255	Machine Design	2	3	3
MDT 210	Statics and Strength of Materials	1	4	3
CAD 213	Plant Engineering Drafting	1	4	3
CAD 270	CAD/CAM Concepts	1	4	3
ENGL 103	Speech Fundamentals	3	0	3
	General Education Requirement	—	—	3
		8	14	18
	Program Totals	35+	44+	68

*** Each Semester is 16 weeks in length**

MASTER PROGRAM

Machine Design

COURSE SYLLABUS

Total lecture hours: 32 **Total lab hours: 48** **Credit hours: 3**

COURSE DESCRIPTION:

Covers the basics of machine design including the design process, types of machines and mechanisms, and the application of machine elements in the design. Computer-aided drafting and design applications are discussed and utilized.

PREREQUISITES:	**Introduction to Computer-Aided Drafting; Machine Elements**
COREQUISITE:	**Statics and Strength of Materials**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:

1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings; and,
5. Assist engineering personnel.

REQUIRED COURSE MATERIALS:

Textbook:	***Engineering Drawing and Design***, Jensen, C., Helsel, J.D., Glencoe/McGraw-Hill, Latest Edition
Supplies:	3.5" high density computer disk

METHODS OF INSTRUCTION:

Lecture:	Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Orientation, Engineering Graphs and Charts	2
Conceptual Design	2
Materials Selection	2
Bearings	2
Shaft Design	2
Brakes and Clutches	2
Engineering Cost Analysis	2
Safety in Design	2
Design Project	12
Presentations, Classroom Critique and Discussion	4
Total Lecture Hours	32

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation, Engineering Graphs and Charts	2
Conceptual Design	2
Materials Selection	2
Bearings	2
Shaft Design	2
Brakes and Clutches	2
Engineering Cost Analysis	2
Safety in Design	2
Design Project	28
Presentations, Classroom Critique and Discussion	4
Total Lab Hours	48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - *A.* ***Resources:*** *Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
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  - *B.* ***Interpersonal:*** *Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C.* ***Information:*** *Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D.* ***Systems:*** *Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
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    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
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   - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
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   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
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    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations
    d. Demonstrates ability to read, interpret, and use standard measuring devices
    e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
    f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
    g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
    a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
    b. Demonstrates ability to hear, comprehend, and appropriately follow directions
    c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
    d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
    e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
    f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
    a. Demonstrates appropriate listening and speaking skills in personal conversations
    b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

  a. Demonstrates ability to objectively assess personal strengths and weaknesses
  b. Demonstrates ability to set realistic short-term and long-term goals
  c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
  d. Demonstrates ability to identify potential pitfalls and take evasive actions
  e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
  f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
  g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

  a. Demonstrates ability to detect problem through observation, inquiry, or directive
  b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
  c. Demonstrates ability to generate alternatives or options for problem solution
  d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

        - e. Demonstrates ability to initiate and effect solution
        - f. Demonstrates ability to take responsibility for outcomes
        - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
    - 3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
        - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
        - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
        - c. Demonstrates ability to visually discriminate in gross and fine imagery
        - d. Demonstrates ability to visualize abstractly
        - e. Demonstrates ability to apply visual imagery to applied tasks
    - 4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
        - a. Demonstrates mastery of basic reading, math, and language skills through application
        - b. Demonstrates ability to translate abstract theory into practical application
        - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
        - d. Demonstrates knowledge of good study skills and learning habits
    - 5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
        - a. Demonstrates use of simple logic
        - b. Demonstrates ability to distinguish relationships
        - c. Demonstrates ability to determine and isolate factors in relationships
        - d. Demonstrates and applies knowledge through practice
        - e. Recognizes that attitudes, skills, and practice are essential to productivity
        - f. Demonstrates ability to discriminate between positive and negative, and act accordingly
- C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
    - 1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

    b. **Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner**
    c. **Demonstrates ability to formulate and follow personal schedules**
    d. **Demonstrates ability to wisely use classroom time**
    e. **Demonstrates use of good study habits and skills**
    f. **Demonstrates maturity to take responsibility for own actions**

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
    a. **Knows and demonstrates ability to distinguish between positive and negative behaviors**
    b. **Demonstrates honesty and integrity in working with peers and supervisors**
    c. **Takes full responsibility for personal actions**
    d. **Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable**
    e. **Demonstrates positive work and social ethics in undertakings**

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A5;
    CAD-B1 through CAD-B5;
    CAD-C1 through CAD-C3;
    CAD-D1 through D-10; and,
    CAD-E1 through CAD-E7.
2. ***Technical Drawing,*** Goetsch, D. L., Nelson, J.A., Chalk, W.S., Delmar Publishers, Latest Edition
3. ***Technical Drawing,*** Giesecke, F.E., et al., Macmillan, Latest Edition
4. ***Machinery's Handbook,*** Oberg, E., et al., Industrial Press, Inc., Latest Edition

MDT 210

MASTER PROGRAM

Statics and Strength of Materials

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Introduces statics and the study of internal stresses in machine members such as equilibrium calculations for loaded beams, columns, and machine structures, static and strengths analysis of bolted and riveted joints, and pressure vessels. Moments of inertia, center of gravity, and centroids are computed; static and kinetic friction are discussed. Standard reference tables are used throughout.

PREREQUISITES: **Machine Elements;**
Trigonometric Functions;
Mechanics, Heat, and Sound

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Apply mathematical concepts; and,
2. Assist engineering personnel.

REQUIRED COURSE MATERIALS:

Textbook: *Statics & Strength of Materials,* Bassin, McGraw Hill, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Fundamental Terms	1
Resultant & Equilibrium for Forces	1
Moments	1
Non-Concurrent Forces Trusses	1
Static & Kinetic Friction	1
Simple Stresses	1
Properties of Materials	1
Bolted, Riveted Joints & Pressure Vessels	2
Center of Gravity, Moments of Inertia & Centroids	1
Beams & Forces	1
Beam Design	2
Shafts & Torsion	1
Columns	1
Statics Reviews	1
Total Lecture Hours	**16**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Fundamental Terms	4
Resultant & Equilibrium for Forces	4
Moments	4
Non-Concurrent Forces Trusses	4
Static & Kinetic Friction	4
Simple Stresses	4
Properties of Materials	4
Bolted, Riveted Joints & Pressure Vessels	8
Center of Gravity, Moments of Inertia & Centroids	4
Beams & Forces	4
Beam Design	8
Shafts & Torsion	4
Columns	4
Statics Reviews	4
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  - *A.* *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  - *B.* *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  - *C.* *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - *D.* *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - *E.* *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    - b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    - c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    - d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

   - e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   - a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   - b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   - c. Demonstrates ability to understand and perform multi-step computations
   - d. Demonstrates ability to read, interpret, and use standard measuring devices
   - e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   - f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   - g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   - a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   - b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   - c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   - d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   - e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   - f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking***: *Organizes ideas and communicates orally*
   - a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution

f. Demonstrates ability to take responsibility for outcomes

g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues

c. Demonstrates ability to visually discriminate in gross and fine imagery

d. Demonstrates ability to visualize abstractly

e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*

a. Demonstrates mastery of basic reading, math, and language skills through application

b. Demonstrates ability to translate abstract theory into practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process

d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. Demonstrates use of simple logic

b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships

d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   CAD-A1 through CAD-A5; and,
   CAD-E7.

CAD 213

MASTER PROGRAM

Plant Engineering Drafting

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Covers piping layouts, symbols and detailing; electrical drafting of wiring diagrams, welding drafting and structural detailing and materials.

PREREQUISITES: **Introduction to Computer-Aided Drafting;**
Tool Drafting;
Technical Mathematics

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Apply mathematical concepts;
2. Demonstrate fundamental drafting skills;
3. Plan and organize activities;
4. Prepare mechanical production drawings;
5. Assist engineering personnel; and,
6. Use a computer-aided drafting system.

REQUIRED COURSE MATERIALS:

Textbook: ***Engineering Drawing and Design,*** Jensen, C., Helsel, J.D., Glencoe/McGraw-Hill, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Class Orientation, Lab Plant Engineering, CAD Overview	1
Permanent Fasteners	3
Wiring Diagrams	2
Orthographic Piping	1
Pictorial Piping	2
Trusses	1
Structural Detailing	2
Schematic Diagrams	1
Material Handling	3
Total Lecture Hours	**16**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Fasteners	12
Wiring Diagrams	8
Orthographic Piping	4
Pictorial Piping	8
Trusses	4
Structural Detailing	8
Schematic Diagrams	8
Material Handling	12
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, *full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."*

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*
    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS
  A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
    a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
    b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

        - d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        - e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        - f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        - g. Demonstrates ability to take responsibility for presentations

- B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    - *1.* ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        - a. Demonstrates ability to objectively assess personal strengths and weaknesses
        - b. Demonstrates ability to set realistic short-term and long-term goals
        - c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        - d. Demonstrates ability to identify potential pitfalls and take evasive actions
        - e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        - f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        - g. Demonstrates maturity in taking responsibility for decisions
    - *2.* ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
        - a. Demonstrates ability to detect problem through observation, inquiry, or directive
        - b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
        - c. Demonstrates ability to generate alternatives or options for problem solution
        - d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
        - e. Demonstrates ability to initiate and effect solution
        - f. Demonstrates ability to take responsibility for outcomes

   - g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   - a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   - b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   - c. Demonstrates ability to visually discriminate in gross and fine imagery
   - d. Demonstrates ability to visualize abstractly
   - e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   - a. Demonstrates mastery of basic reading, math, and language skills through application
   - b. Demonstrates ability to translate abstract theory into practical application
   - c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   - d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   - a. Demonstrates use of simple logic
   - b. Demonstrates ability to distinguish relationships
   - c. Demonstrates ability to determine and isolate factors in relationships
   - d. Demonstrates and applies knowledge through practice
   - e. Recognizes that attitudes, skills, and practice are essential to productivity
   - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules

- d. Demonstrates ability to wisely use classroom time
- e. Demonstrates use of good study habits and skills
- f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
    - a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    - b. Demonstrates honesty and integrity in working with peers and supervisors
    - c. Takes full responsibility for personal actions
    - d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    - e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2;
    CAD-A4 through CAD-A5;
    CAD-B1 through CAD-B5;
    CAD-C1 through CAD-C3;
    CAD-D1;
    CAD-D4 through CAD-D10;
    CAD-E2;
    CAD-F1 through CAD-F12; and,
    CAD-F16 through CAD-F17.

MASTER PROGRAM

CAD/CAM Concepts

COURSE SYLLABUS

Total lecture hours: 16 **Total lab hours: 64** **Credit hours: 3**

COURSE DESCRIPTION:

Focuses on theory and concepts in the fundamentals of programming a CAD-based system to generate numerical control programs for production machinery. Creation of tool databases, machining curves and tool paths for lathes and mills are covered, as are tool and turret statements, machine characteristics, post processors, and tape utilities. Machining of parts is not included in this fundamental course.

PREREQUISITES: **Introduction to Computer-Aided Drafting; 3-D Modeling and Rendering**

COURSE OBJECTIVES:

Upon successful completion of this course, the students will be able to:

1. Identify the parts of a CAD/CAM system and describe their function;
2. Manipulate a part database for machining;
3. Manipulate a tool database for lathe and mill operations;
4. Create tool curves for the CAM process;
5. Create a tool database for lathe and mill operations;
6. Save and retrieve CAM files;
7. Use CAM menus;
8. Use CAM codes and symbols;
9. Perform CAM command operations properly;
10. Join and reverse machining curves;
11. Translate and rotate part curves; and,
12. Perform sequencing and tool change operations.

REQUIRED COURSE MATERIALS:

Textbook: Instructor supplied handouts

Supplies: Two 3.5" high-density disk

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Laboratory: Laboratory will be hands-on activities.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete assignments;
2. Apply theory to assignments;
3. Perform on written, oral, or practical examinations;
4. Perform on outside assignments, including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all rules and safety regulations as stated in the manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
CAD review	1
Using text editors, creating and editing a part database	1
Generating part curves	1
Using tool/turret libraries	1
CAM system commands	1
Part geometry curve manipulation	1
Sequence commands	1
Tool path generation, tool path view manipulation, tool path editing	2
Program output	1
Post processing, tape utilities	2
CNC/DNC	2
Final exam	2
Total Lecture Hours	16

LAB OUTLINE:

Lab Topics	Contact Hrs.
CAD review	4
Using text editors, creating and editing a part database	4
Generating part curves	4
Using tool/turret libraries	4

CAM system commands	4
Part geometry curve manipulation	4
Sequence commands	4
Tool path generation, tool path view manipulation, tool path editing	8
Program output	4
Post processing, tape utilities	4
CNC/DNC	4
Final exam	16
Total Lab Hours	**64**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
  A. *Resources: Identifies, organizes, plans, and allocates resources*
    1. Allocates time to complete assigned tasks on schedule
    2. Determines and allocates required materials and resources for meeting objectives
    3. Evaluates skills, performance, and quality of work and provides feedback
  B. *Interpersonal: Works with others*
    1. Participates as a member of the team, contributing to group effort
    2. Provides individual assistance/direction to peers as requested
    3. Determines and meets expectations
    4. Exercises leadership qualities to effectively communicate ideas and make decisions.
    5. Negotiates resources in order to accomplish objectives
    6. Works well with all members of the class
  C. *Information: Acquires and uses information*

    1. Acquires and evaluates information
    2. Organizes and maintains information
    3. Interprets and communicates information
  - D. *Systems: Understands complex inter-relationships*
    1. Understands and works well with social, organizational, and technological systems
    2. Monitors and corrects performance of system during operation
    3. Recommends modifications to system to improve performance
  - E. *Technology: Works with a variety of technologies*
    1. Chooses relevant procedures, tools, and equipment
    2. Applies appropriate procedures and techniques to accomplish tasks
    3. Identifies or solves problems to maintain equipment

- II. FOUNDATION SKILLS
  - A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
    1. ***Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
       - a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
       - b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
       - c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
       - d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
       - e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
    2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
       - a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted

grammatical and communication standards required for effective daily functioning

   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

        d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
        e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
        f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
    5. *Speaking*: *Organizes ideas and communicates orally*
        a. Demonstrates appropriate listening and speaking skills in personal conversations
        b. Demonstrates ability to choose and organize appropriate words to effectively communicate
        c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
        d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
        e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
        f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
        g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
    1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
        a. Demonstrates ability to objectively assess personal strengths and weaknesses
        b. Demonstrates ability to set realistic short-term and long-term goals
        c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
        d. Demonstrates ability to identify potential pitfalls and take evasive actions
        e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
        f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
        g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
    b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
    c. Demonstrates ability to visually discriminate in gross and fine imagery
    d. Demonstrates ability to visualize abstractly
    e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
    a. Demonstrates mastery of basic reading, math, and language skills through application
    b. Demonstrates ability to translate abstract theory into practical application
    c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
    d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships

  - c. Demonstrates ability to determine and isolate factors in relationships
  - d. Demonstrates and applies knowledge through practice
  - e. Recognizes that attitudes, skills, and practice are essential to productivity
  - f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

- *1.* ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
  - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
  - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
  - c. Demonstrates ability to focus on task at hand and work to completion
  - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
  - e. Demonstrates maturity to take responsibility for actions
  - f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
- *2.* ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
  - a. Presents a positive attitude toward tasks
  - b. Demonstrates ability to separate work and personal behaviors
  - c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
  - d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
  - e. Demonstrates ability to accept and use constructive criticism
  - f. Accepts positive reinforcement in an appropriate manner
- *3.* ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
  - a. Demonstrates appropriate and acceptable social behaviors in interactions
  - b. Demonstrates ability to work cooperatively in individual, team, or group situations

    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement
    b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
    c. Demonstrates ability to formulate and follow personal schedules
    d. Demonstrates ability to wisely use classroom time
    e. Demonstrates use of good study habits and skills
    f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
    a. Knows and demonstrates ability to distinguish between positive and negative behaviors
    b. Demonstrates honesty and integrity in working with peers and supervisors
    c. Takes full responsibility for personal actions
    d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
    e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
    CAD-A1 through CAD-A2;
    CAD-A4 through CAD-A5;
    CAD-B1 through CAD-B5;
    CAD-C1 through CAD-C3;
    CAD-D1 through CAD-D4;
    CAD-E5;
    CAD-F1 through CAD-F13; and,
    CAD-F15 through CAD-F17.

MASTER PROGRAM

Speech Fundamentals

COURSE SYLLABUS

Total lecture hours: 48 **Total lab hours: 0** **Credit hours: 3**

COURSE DESCRIPTION:

Introduction to basic oral communication principles and skills, challenges of cultural diversity and gender equity. Includes study and practice in public speaking and discussion, preparation and organization, and delivery techniques. This course satisfies the requirements of Public Act 87-581.

PREREQUISITES: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to:
1. Organize, plan, and write an oral presentation; and,
2. Give oral presentations to small groups.

REQUIRED COURSE MATERIALS:

Textbook: *The Art of Public Speaking*, Lucks, Stephen E., Random House, Latest Edition

Supplies: None

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures and instructor demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:
1. Perform on written, oral, or practical examinations;
2. Perform on outside assignments, including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Course and Symposium, Discussion	
Lecture: The Dynamics of Human Communication	
Class Exercises: Active Listening	
Lecture: Communication	
Group Meetings in Preparation for Symposium, Discussion	
Lecture: Introduction to Informative Speaking	
Videotape, Symposium, Discussion	
Lecture: Informative Speech Organization	
Informative speeches are due for all students	
Assign vocal variety exercise	
Lecture: Introduction to Persuasive Speaking	
Audience Analysis Exercise	
Lecture: Organizing the Persuasive Speech	
Individual conferences	
Continue discussing persuasive speech: logical, emotional, credibility appeals	
Vocal Variety exercises are due	
Persuasive speeches begin	
Introduction to Special Occasion Speaking	
Group meetings in preparation for Final Exam Review	
Final Exam Review groups are due for all students	
Text: All lecture notes, text should be reviewed	
Special Occasion Speeches are due for all students	
Self evaluations are due for all students	
Final Exam Week	
Total Lecture Hours	48

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

- **I. COMPETENCIES**
  - ***A. Resources: Identifies, organizes, plans, and allocates resources***
    - **1. Allocates time to complete assigned tasks on schedule**
    - **2. Determines and allocates required materials and resources for meeting objectives**
    - **3. Evaluates skills, performance, and quality of work and provides feedback**
  - ***B. Interpersonal: Works with others***
    - **1. Participates as a member of the team, contributing to group effort**
    - **2. Provides individual assistance/direction to peers as requested**
    - **3. Determines and meets expectations**
    - **4. Exercises leadership qualities to effectively communicate ideas and make decisions.**
    - **5. Negotiates resources in order to accomplish objectives**
    - **6. Works well with all members of the class**
  - ***C. Information: Acquires and uses information***
    - **1. Acquires and evaluates information**
    - **2. Organizes and maintains information**
    - **3. Interprets and communicates information**
  - ***D. Systems: Understands complex inter-relationships***
    - **1. Understands and works well with social, organizational, and technological systems**
    - **2. Monitors and corrects performance of system during operation**
    - **3. Recommends modifications to system to improve performance**
  - ***E. Technology: Works with a variety of technologies***
    - **1. Chooses relevant procedures, tools, and equipment**
    - **2. Applies appropriate procedures and techniques to accomplish tasks**
    - **3. Identifies or solves problems to maintain equipment**

- **II. FOUNDATION SKILLS**
  - **A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks**
    - ***1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules***
      - **a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts**

    b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
    c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
    d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
    e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
    a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
    b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
    c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
    d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
    e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
    a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
    b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
    c. Demonstrates ability to understand and perform multi-step computations

   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
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   a. Demonstrates appropriate listening and speaking skills in personal conversations
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B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
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- b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
- c. Demonstrates ability to visually discriminate in gross and fine imagery
- d. Demonstrates ability to visualize abstractly
- e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
    - a. Demonstrates mastery of basic reading, math, and language skills through application
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1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
    - a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    - b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    - c. Demonstrates ability to focus on task at hand and work to completion
    - d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
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   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
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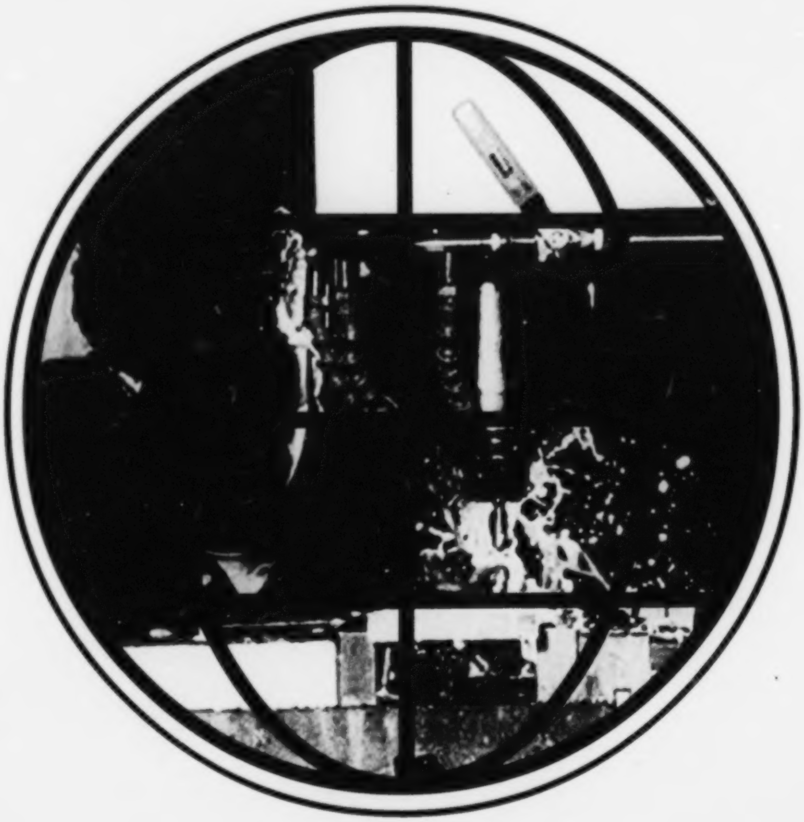
MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES
FOR THE
MACHINE TOOL INDUSTRY



Computer-Aided Drafting & Design Series
INSTRUCTOR'S HANDBOOK

Supported by the National Science Foundation's Advanced Technological Education Program

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"Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Foundation."

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National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, PALOS HILLS, IL
Moraine Valley Community College
Center for Contemporary Technology

Dr. Vernon O. Crawley, President
Moraine Valley Community College
Dr. Richard Hinckley
Dean, Business and Industrial Technology
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Center phone: 708/974-5410, fax:708/974-0078
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Manufacturing in Moraine Valley

The metropolitan Chicago area, including northwestern Indiana, is among the most heavily industrialized areas of the United States. The neighboring Moraine Valley area is home to hundreds of the small- to medium-sized companies that supply the larger industrial concerns, including design, fabrication, metalworking and parts-assembly firms. The diversity of industry in the region and the continual need for qualified entry-level technicians and retraining of current workers has created a great demand for the development of industrial training and the services of Moraine Valley Community College and its Center for Contemporary Technology.

Moraine Valley Community College (MVCC) and the Center for Contemporary Technology (CTT)

Moraine Valley Community College (MVCC) is a public, postsecondary institution serving all or part of 26 communities in the southwest suburban area of Cook County, representing a population of more than 380,000. Located 25 miles southwest of downtown Chicago in Palos Hills, the college is the fourth largest community college in Illinois and serves a diverse student body drawn from the surrounding communities. The focal point for business and industry training in Moraine Valley is the 124,000 s.f. Center for Contemporary Technology (CTT). Opened in 1988, the Center is among the finest and most diverse advanced technology centers (ATC's) in the nation, with over $6 million of equipment and technology to provide training and education in Automated Manufacturing; Automotive Technology; Computer-Aided Design; Corrosion Mitigation; Electronics/Telecommunications; Environmental Control Technology; Information Management; Machining; Mechanical & Fluid Power Maintenance; Non-Destructive Evaluation; and Welding.

Development Team

- **Project Director**: Richard Hinckley, PhD., Dean of Instruction for Business and Industrial Technology and manager of the Center for Contemporary Technology, served as director for the MASTER project.
- **Subject Matter Expert**: Charles H. Bales, Instructor of Mechanical Design/Drafting, had program responsibility for developing skill standards and course/program materials for the mechanical design/drafting component of the MASTER project. Professor Bales also served as lead instructor for the MASTER pilot program in Computer-Aided Drafting and Design (CADD) Technician.
- **Skills Validation Coordinator**: Richard Kukac, MPA, Associate Dean of Instruction of Business and Industrial Technology, coordinated the industry skills verification process for MASTER and facilitated the industry validation sessions with teams of expert practitioners from the skill area.

Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).**

Each Technical Training Module has been designed to be:

- Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as "competency-based training".
- Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.
- Modular in design, to allow trainers to select lessons which are applicable to their training needs.
- Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.

- Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:
    - a standardized lesson plan,
    - an assessment instrument,
    - a listing of commercially available resources (e.g. recommended textbooks, instructor guides, student manuals, and videos),
    - new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... **plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.**

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management technique	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

Duties		Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-A1

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Perform Basic Arithmetic Operations

Objective(s):

Upon completion of this unit the student will be able to:
a. Add, subtract, multiply, and divide real numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Convert real numbers to fractional equivalents and vice versa.

Instructional Materials:

MASTER Handout (CAD-A1-HO)
MASTER Laboratory Aid (CAD-A1-LA)
MASTER Laboratory Exercise (CAD-A1-LE)
MASTER Self-Assessment

References:

Mathematics for Machine Technology, R. D. Smith, Delmar Publishers, Inc., Latest Edition

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Student Preparation:

This is an introductory level Technical Module; therefore, there are no prerequisite technical modules.

Introduction:

A strong foundation of technical mathematics is essential in developing the skills necessary to be a competent mechanical design technician. The basis of technical mathematics can be found in arithmetic, that is: adding, subtracting, multiplying, and dividing numbers. Without this knowledge, further progress in this and many or technical disciplines is not possible.

Presentation Outline:

- I. Add, Subtract, Multiply, and Divide Whole Numbers
    - A. Addition of whole numbers
    - B. Subtraction of whole numbers
    - C. Multiplication of whole numbers
    - D. Division of whole numbers
    - E. Hierarchy of operations
- II. Add, Subtract, Multiply, and Divide Fractions
    - A. Common operations
        - 1. Least common denominator
        - 2. Factoring for reduction
        - 3. Improper fractions
        - 4. Mixed numbers
    - B. Addition
    - C. Subtraction
    - D. Multiplication
    - E. Division
- III. Add, Subtract, Multiply, and Divide Decimals
    - A. Aligning the decimal (addition and subtraction)
    - B. Moving the decimal
        - 1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
        - 2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit,* count off the same number of places and place the decimal.
- IV. Real numbers (with decimals)
    - A. Round real numbers
    - B. Identify significant digits
    - C. Add real numbers
    - D. Subtract real numbers
    - E. Multiply real numbers
    - F. Express numbers in scientific notation
    - G. Divide real numbers
- V. Conversion
    - A. Express decimals as fractions
    - B. Express fractions as decimals
    - C. Express a decimal or fraction as a percent
    - D. Express a percent as a decimal or fraction

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;

b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,

c) Solve word problems (based on technical applications).

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above.)

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-A2), in which the students will use the arithmetic skills developed in this technical module to convert units from one system of measurement to another.

CAD-A1-HO
Perform Basic Arithmetic Operations
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

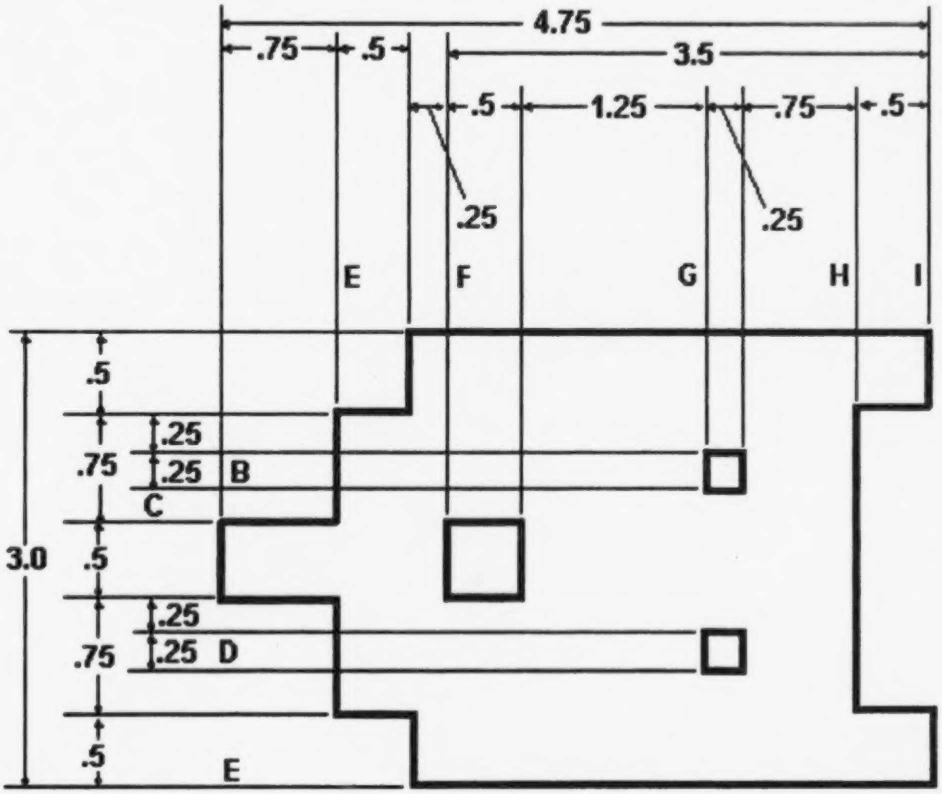
a. Add, subtract, multiply, and divide real numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Convert real numbers to fractional equivalents and vice versa.

Module Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
    A. Addition of whole numbers
    B. Subtraction of whole numbers
    C. Multiplication of whole numbers
    D. Division of whole numbers
    E. Hierarchy of operations
II. Add, Subtract, Multiply, and Divide Fractions
    A. Common operations
        1. Least common denominator
        2. Factoring for reduction
        3. Improper fractions
        4. Mixed numbers
    B. Addition
    C. Subtraction
    D. Multiplication
    E. Division
III. Add, Subtract, Multiply, and Divide Decimals
    A. Aligning the decimal (addition and subtraction)
    B. Moving the decimal
        1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
        2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit,* count off the same number of places and place the decimal.
IV. Real numbers (with decimals)
    A. Round real numbers
    B. Identify significant digits
    C. Add real numbers
    D. Subtract real numbers

E. Multiply real numbers
F. Express numbers in scientific notation
G. Divide real numbers

V. Conversion
A. Express decimals as fractions
B. Express fractions as decimals
C. Express a decimal or fraction as a percent
D. Express a percent as a decimal or fraction


4.75
.75
.5
3.5
.5
1.25
.75
.5
.25
.25
E
F
G
H
I
.5
.25
.75
.25
B
C
3.0
.5
.25
.75
.25
D
.5
E

CAD-A1-LE
Perform Basic Arithmetic Operations
Attachment 3: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;

b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,

c) Solve word problems (based on technical applications).

Name____________________ Date______________

CAD-A1
Perform Basic Arithmetic Operations
Self-Assessment

Show all work.

Reduce the following fractions:

1. 4/64 ______________________________
2. 6/4 ______________________________
3. 6/16 ______________________________
4. 12/32 ______________________________
5. 9/16 ______________________________

Perform the indicated operations:

6. 3.25 + 2.375 = ______________________________
7. 15/32 + 1/4 = ______________________________
8. 15/32 - 1/4 = ______________________________
9. 9/64 + 9/32 = ______________________________
10. 1/4 x 3/4 = ______________________________
11. 1/4 ÷ 3/4 = ______________________________
12. 0.625 x 1/4 = ______________________________
13. 0.625 + 1.125 = ______________________________
14. 1.125 - 0.75 = ______________________________
15. 1.25/1.5 = ______________________________

For Questions 16 through 25, use the dimensional notations on the drawing.

16. What is the distance between Line A and Line B? ____________________

17. What is the distance between Line B and Line C? ____________________

18. What is the distance between Line B and Line D? ____________________

19. What is the distance between Line C and Line E? ____________________

20. What is the distance between Line C and Line D? ____________________

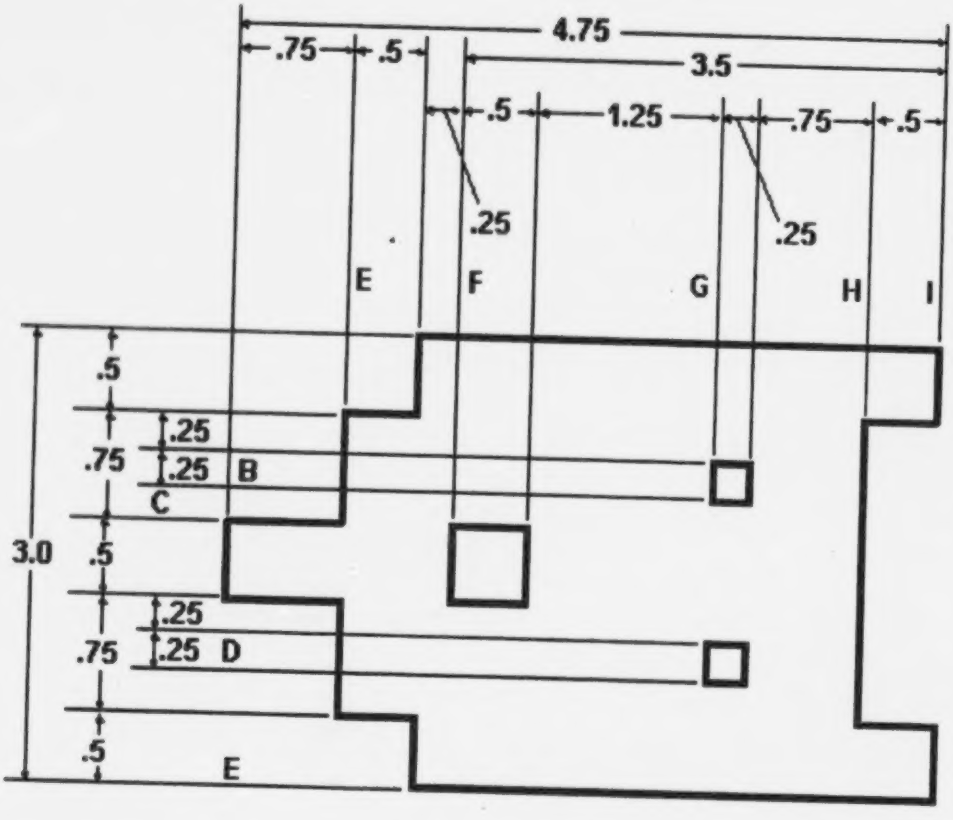
21. What is the distance between Line E and Line F? ____________________

22. What is the distance between Line F and Line G? ____________________

23. What is the distance between Line F and Line I? ____________________

24. What is the distance between Line G and Line H? ____________________

25. What is the distance between Line I and Line E? ____________________


4.75
.75
.5
3.5
.5
1.25
.75
.5
.25
.25
E
F
G
H
I
3.0
.5
.75
.25
.25
B
C
.5
.75
.25
.25
D
.5
E

CAD-A1
Perform Basic Arithmetic Operations
Self-Assessment Answer Key

1. 1/16
2. 1 ½
3. 3/8
4. 3/8
5. 9/16
6. 5.625
7. 23/32
8. 7/32
9. 27/64
10. 3/16
11. 1/3
12. 0.156
13. 1.75
14. 0.375
15. 0.833
16. 0.75
17. 0.25
18. 1.25
19. 1.75
20. 1.0
21. 0.75
22. 1.75
23. 3.25
24. 1.0
25. 4.0

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-A2

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Compute Unit Conversions

Objective(s):

Upon completion of this unit the student will be able to:
a. Convert English units to metric units and vice versa; and,
b. Calculate unit conversion ratios.

Instructional Materials:

Table of English/metric conversions (provided on Self-Assessment)
Calculators for students
MASTER Handout (CAD-A2-HO)
MASTER Laboratory Exercise (CAD-A2-LE)
MASTER Self-Assessment

References:

Mathematics for Machine Technology, R. D. Smith, Delmar Publishers, Inc., Latest Edition, Section 2, Linear Measurement: English and Metric

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-A1 "Perform Basic Arithmetic Operations"

Introduction:

A strong foundation of technical mathematics is essential in developing the skills necessary to be a competent mechanical design technician. The basis of technical mathematics can be found in arithmetic, that is: adding, subtracting, multiplying, and dividing numbers. Without this knowledge, further progress in this and many or technical disciplines is not possible.

Presentation Outline:

I. Metric (SI) System of Measurement
  a. Metric units
  b. Conversions within the metric system (e.g. meter to millimeter, gram to kilogram)
II. English System of Measurement
  A. English units
  B. Conversions within the English system (e.g. feet to miles, ounce to pound)
III. System Conversions
  A. Conversion factors
  B. Conversion from metric to English
  C. Conversion from English to metric

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Solve given mathematical problems, showing all work;
b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,
c) Solve word problems (based on technical applications).

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-A3), in which the students will use the arithmetic skills developed in this technical module to begin a study of basic trigonometric functions and operations.

CAD-A2-HO
Compute Unit Conversions
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Convert English units to metric units and vice versa; and,
- b. Calculate unit conversion ratios.

Module Outline:

- I. Metric (SI) System of Measurement
  - a. Metric units
  - b. Conversions within the metric system (e.g. meter to millimeter, gram to kilogram)
- II. English System of Measurement
  - A. English units
  - B. Conversions within the English system (e.g. feet to miles, ounce to pound)
- III. System Conversions
  - A. Conversion factors
  - B. Conversion from metric to English
  - C. Conversion from English to metric

CAD-A2-LE
Compute Unit Conversions
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;

b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,

c) Solve word problems (based on technical applications).

Name____________________________ Date_______________

CAD-A2
Compute Unit Conversions
Self-Assessment

Circle the letter preceding the correct answer.

Convert the following metric measurements to English equivalents using the following conversion factors:

1 millimeter (mm) = 0.03937 inch (in)
1 centimeter (cm) = 0.3937 inch (in)
1 meter (m) = 39.37 inches (in)
1 meter (m) = 3.2808 feet (ft)

1. 5 mm = _____ in
   - a. 0.19685
   - b. 1.565
   - c. 0.6875
   - d. 2.675

2. 2 cm = _____ in
   - a. 0.875
   - b. 0.7874
   - c. 6875
   - d. 2.175

3. 2 m = _____ ft
   - a. 5
   - b. 6.958
   - c. 6.5616
   - d. 8

4. 20 m = _____ ft.
   - a. 45
   - b. 65.616
   - c. 40
   - d. 25

5. 20 cm = _____ in
   - a. 2.0
   - b. 1.5
   - c. 7.874
   - d. 3.0

Write the following English units as metric units using the following conversion factors:

1 inch (in) = 25.4 millimeters (mm)
1 inch (in) = 2.54 centimeters (cm)
1 foot (ft) = 0.3048 meter (m)

6. 2 in = _____ mm
   - a. 50.9
   - b. 65
   - c. 79
   - d. 19

7. 2 in = _____ cm
   - a. 15
   - b. 24
   - c. 5.09
   - d. 150

8. 10 ft = _____ m
   - a. 3.048
   - b. 38
   - c. 4
   - d. 1.4

CAD-A2
Compute Unit Conversions
Self-Assessment Answer Key

1. A
2. B
3. C
4. B
5. C
6. A
7. C
8. A

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-A3

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Perform Basic Trigonometric Operations

Objective(s):

Upon completion of this unit the student will be able to:
a. Use trigonometric functions to calculate angles; and,
b. Use trigonometric functions to calculate linear distances.

Instructional Materials:

Calculator (with trigonometric function capability) or trigonometric function tables
Protractor
Scale
MASTER Handout (CAD-A3-HO)
MASTER Laboratory Aid (CAD-A3-LA)
MASTER Laboratory Exercise (CAD-A3-LE)
MASTER Self-Assessment

References:

Mathematics for Machine Technology, R. D. Smith, Delmar Publishers, Inc., Latest Edition
Machinery's Handbook, Industrial Press, Latest Edition, "Solution of Triangles"

Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-A1 "Perform Basic Arithmetic Operations"
CAD-A2 "Compute Unit Conversions"

Introduction:

A strong foundation of technical mathematics is essential in developing the skills necessary to be a competent mechanical design technician. The basis of technical mathematics can be found in arithmetic, that is: adding, subtracting, multiplying, and dividing numbers. Without this knowledge, further progress in this and many or technical disciplines is not possible.

Presentation Outline:

I. Angles
    A. Determine the quadrant of a given angle
    B. Identify the coterminal angles
    C. Express the degree measure of an angle as a radian measure and vice-versa
II. Trigonometric Functions
    A. Define trigonometric functions (ratios)
    B. Determine the trigonometric ratios of acute angles of a right triangle
    C. Find the value of trigonometric ratios of angles between 0° and 90°
    D. Find the trigonometric ratios for obtuse angles
III. Solve Triangles (Determine Lengths and/or Angles)
    A. Solve right triangles
    B. Solve oblique triangles
        1. Solve using Law of Sines
        2. Solve using Law of Cosine

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;
b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,
c) Solve word problems (based on technical applications).

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-A4) in which the students will learn to use the Cartesian (rectangular) coordinate system.

CAD-A3-HO
Perform Basic Trigonometric Operations
Attachment 1: MASTER Handout

Objective(s):

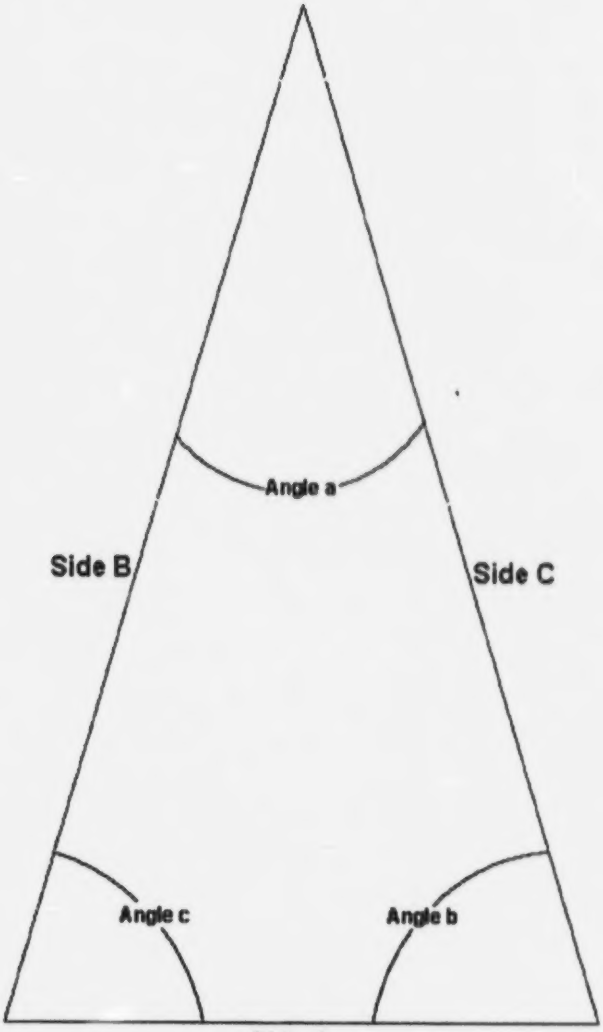
Upon completion of this unit the student will be able to:

a. Use trigonometric functions to calculate angles; and,
b. Use trigonometric functions to calculate linear distances.

Module Outline:

I. Angles
   A. Determine the quadrant of a given angle
   B. Identify the coterminal angles
   C. Express the degree measure of an angle as a radian measure and vice-versa
II. Trigonometric Functions
   A. Define trigonometric functions (ratios)
   B. Determine the trigonometric ratios of acute angles of a right triangle
   C. Find the value of trigonometric ratios of angles between 0° and 90°
   D. Find the trigonometric ratios for obtuse angles
III. Solve Triangles (Determine Lengths and/or Angles)
   A. Solve right triangles
   B. Solve oblique triangles
      1. Solve using Law of Sines
      2. Solve using Law of Cosine

CAD-A3-LA
Perform Basic Trigonometric Operations
Attachment 2: MASTER Laboratory Aid


Angle a
Side B
Side C
Angle c
Angle b
Side A

Basic Triangle - CAD-A3

CAD-A3-LE
Perform Basic Trigonometric Operations
Attachment 3: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;
b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,
c) Solve word problems (based on technical applications).

Name______________________________ Date________________

CAD-A3
Perform Basic Trigonometric Operations
Self-Assessment

Using the reference triangle on the accompanying page, solve the following triangles from the information given. Show all work.

1. Side A = 9"; Side B = 8"; Side C = 12"; solve for all angles. The triangle is oblique.

2. Side A = 6 cm; Angle *c* = 60°; Side B = 12 cm; solve for Angle *a*..

3. Angle *a* = 35°; Angle *b* = 57° 30'; solve for Angle *c*.

4. Angle *a* = 40°; Side A = 18"; Side B = 12"; solve for Angles *b* & *c*.

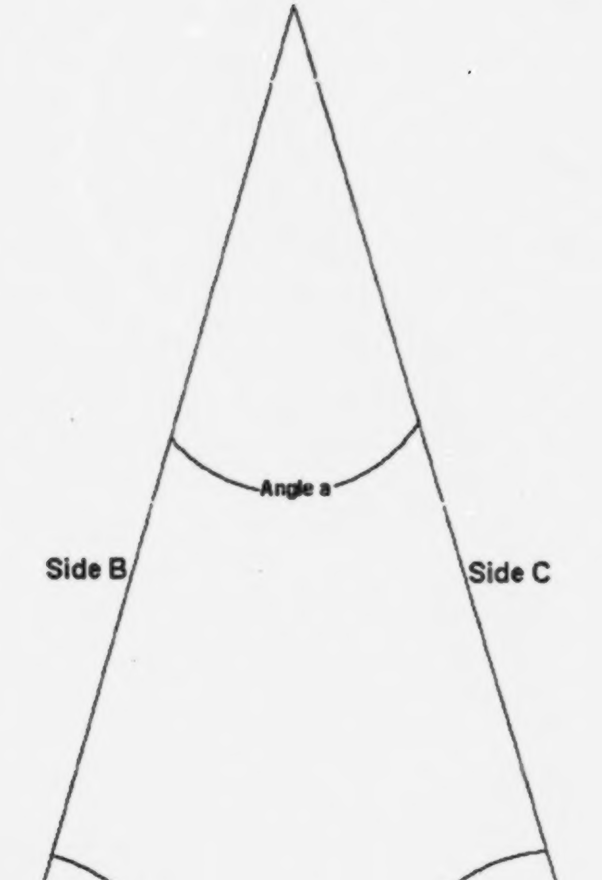
5. Side A = cm; Angle *c* = 90°; Side B = 12 cm; solve for Side C.

6. Angle *a* = 22° 30'; Angle *b* = Angle *a*; Side A = 9"; solve for Sides B & C.

7. Side A = 12 cm; Side B = 12 cm; Angle *c* = 60°; solve for Side C.

8. The triangle is a right triangle. Side A = 3'; Side B = 4'; Side C = 5'; solve for all angles.

9. A right triangle has two 45° angles. Solve for the sides, in inches.


Angle a
Side B
Side C
Angle c
Angle b
Side A

Basic Triangle - CAD-A3

CAD-A3
Perform Basic Trigonometric Operations
Self-Assessment Answer Key

1. a = 48.59° b = 41.81° c = 89.6°

2. a = 86.11°

3. c = 87° 30'

4. b = 25.37° c =114.63°

5. Side C = 13.41 cm

6. Side B = 9" Side C = 16.63"

7. Side C = 12 cm

8. Angle a = 36.87° Angle b = 53.13° Angle c = 90°

9. The problem is impossible to solve.

CAD-A4

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-A4

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Use the Cartesian Coordinate System

Objective(s):

Upon completion of this unit the student will be able to:

a. Read and understand Cartesian coordinate data; and,
b. Plot Cartesian coordinate data.

Instructional Materials:

Cartesian (rectangular) graph paper (various scales)
Scale
MASTER Handout (CAD-A4-HO)
MASTER Laboratory Exercise (CAD-A4-LE)

References:

The following are recommended as reference material: a technical mathematics textbook discussing the Cartesian coordinate system

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-A1	'Perform Basic Arithmetic Operations'
CAD-A2	'Compute Unit Conversions'
CAD-A3	'Perform Basic Trigonometric Calculations'

Introduction:

The proper application of coordinate information is essential to the designer/drafter. Technical data is often displayed using a graph, and every CAD/CAM system is based upon a coordinate system. Therefore a knowledge of the two main coordinate systems, Cartesian (rectangular) and polar, is necessary.

We will begin with the Cartesian system, the most basic and also the most common. This study will focus on two-dimensional geometric construction.

Presentation Outline:

- I. Plot Cartesian Coordinate Data Points on Cartesian Graph Paper
- II. Convert Graphical Data into Cartesian Coordinate Pairs
- III. Construct Two-dimensional (Flat) Shapes Using Cartesian Coordinate Data
  - A. Use absolute Cartesian coordinate transformations
  - B. Use relative Cartesian coordinate transformations

Practical Application:

Students will be given classwork and homework assignments in which they must:

- a) Plot data on graph paper given Cartesian coordinate data;
- b) Convert graphical data into Cartesian coordinate pairs; and,
- c) Construct two-dimensional shapes on graph paper given Cartesian coordinate data.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above) and the successful completion of a Self-Assessment covering the subject matter.

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-A5) in which the students will learn to plot data using a polar coordinate system.

CAD-A4-HO
Use the Cartesian Coordinate System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Read and understand Cartesian coordinate data; and,
b. Plot Cartesian coordinate data.

Module Outline:

I. Plot Cartesian Coordinate Data Points on Cartesian Graph Paper
II. Convert Graphical Data into Cartesian Coordinate Pairs
III. Construct Two-dimensional (Flat) Shapes Using Cartesian Coordinate Data
    A. Use absolute Cartesian coordinate transformations
    B. Use relative Cartesian coordinate transformations

CAD-A4-LE
Use the Cartesian Coordinate System
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Plot data on graph paper given Cartesian coordinate data;
b) Convert graphical data into Cartesian coordinate pairs; and,
c) Construct two-dimensional shapes on graph paper given Cartesian coordinate data.

CAD-A5

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-A5

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Apply Mathematical Concepts**
Task: Use the Polar Coordinate System

Objective(s):

Upon completion of this unit the student will be able to:
a. Read and understand polar coordinate data;
b. Interpret polar coordinate data; and,
c. Plot polar coordinate date.

Instructional Materials:

Polar graph paper (various scales)
Scale
MASTER Handout (CAD-A5-HO)
MASTER Laboratory Exercise (CAD-A5-LE)

References:

The following are recommended as reference material: a technical mathematics textbook discussing the polar coordinate system

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Student Preparation:

Students should have previously he following Technical Modules:

CAD-A1	"Perform Basic Arithmetic Operations'
CAD-A2	"Compute Unit Conversions'
CAD-A3	"Perform Basic Trigonometric Calculations'
CAD-A4	"Use the Cartesian Coordinate System'

Introduction:

The proper application of coordinate information is essential to the designer/drafter. Technical data is often displayed using a graph, and every CAD/CAM system is based upon a coordinate system. Therefore a knowledge of the two main coordinate systems, Cartesian (rectangular) and polar, is necessary.

From the discussion of the Cartesian coordinate system in module CAD-A4, we will move forward to a discussion of the polar coordinate system. This module will primarily focus on two-dimensional data, but will include construction of two-dimensional shapes from polar and Cartesian coordinate data.

Presentation Outline:

I. Plot Polar Coordinate Data Points on Polar Graph Paper
II. Convert from Polar Coordinates to Cartesian Coordinates, and Vice-Versa
III. Construct Two-dimensional (Flat) Shapes Using Polar Coordinate Data
    A. Use absolute polar coordinate transformations
    B. Use relative polar coordinate transformations
IV. Construct Two-dimensional (Flat) Shapes Using a Combination of Cartesian and Polar Coordinate Data

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Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Plot data on graph paper;
b) Convert from polar coordinates to Cartesian coordinate and vice-versa given the respective coordinate pairs (all work must be shown); and,
c) Construct two-dimensional shapes on graph paper given polar and Cartesian coordinate data.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above) and the successful completion of a Self-Assessment covering the subject matter.

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This is the last technical module under Duty A: Apply Mathematical Concept. The next duty is B: Demonstrate Fundamental Drafting Skills, and the first **MASTER Technical Module is CAD-B1** dealing with using drawing media and related drafting materials.

CAD-A5-HO
Use the Polar Coordinate System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Read and understand polar coordinate data;
- b. Interpret polar coordinate data; and,
- c. Plot polar coordinate date;

Module Outline:

- I. Plot Polar Coordinate Data Points on Polar Graph Paper
- II. Convert from Polar Coordinates to Cartesian Coordinates, and Vice-Versa
- III. Construct Two-dimensional (Flat) Shapes Using Polar Coordinate Data
  - A. Use absolute polar coordinate transformations
  - B. Use relative polar coordinate transformations
- IV. Construct Two-dimensional (Flat) Shapes Using a Combination of Cartesian and Polar Coordinate Data

CAD-A5-LE
Use the Polar Coordinate System
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Plot data on graph paper;

b) Convert from polar coordinates to Cartesian coordinate and vice-versa given the respective coordinate pairs (all work must be shown); and,

c) Construct two-dimensional shapes on graph paper given polar and Cartesian coordinate data.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

Duties		Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

CAD PW

DutyB

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-B1

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Demonstrate Fundamental Drafting Skills**
Task: Use Drawing Media and Related Drafting Materials

Objective(s):

Upon completion of this unit the student will be able to:
a. Select drawing media; and,
b. Select related drafting materials.

Instructional Materials:

- Textbook
- Drafting materials:
  - Pencils (lead pointer, mechanical pencil)
  - Various leads (4H to 2B)
  - Triangles (30°-60°-90°, 45°-45°-90°, adjustable)
  - Paper of various sizes (A, B, C, D, E sizes)
  - Scales (mechanical, engineers, metric)
  - Templates
  - T-square or parallel-ruling edge or drafting machine
  - Eraser
  - Drafting tape
- **MASTER** Handout (CAD-B1-HO)
- **MASTER** Laboratory Exercise (CAD-B1-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

This is an introductory level Technical Module; therefore, there is no special preparation necessary.

Introduction:

Although the advent of computer-aided drafting software has greatly improved the practice of drafting, there are many instances where a drafter must use manual methods for technical sketching or preparing production drawings. Some companies have also not fully implemented CAD into their workplace.

There are various ways to prepare and present mechanical drawings and the student must be familiar with each one. Preparing a drawing often requires the use of multiple lead types, various triangles, templates of one sort or another, and a many other items. Each drawing may be on different paper sizes ranging from A-size to E-size, and the paper type could change, as well.

Presentation Outline:

I. Drawing Media
    A. Types
        1. Drawing papers
            a. 100% rag content
            b. White or light cream
            c. For pencil drawing
            d. Can be used for CAD plotting
        2. Ink papers
            a. Similar to 100% rag content paper
            b. Thicker ply: 2-ply, 3-ply, or 4-ply
            c. White
            d. Used for CAD plotting
        3. Tracing papers/vellums
            a. Transparent
            b. Used for reproduction
            c. Used for pencil or ink
            d. Good for blueprinting
        4. Polyester film
            a. Superior material, expensive
            b. Transparent
            c. Easy erasing, no ghost marks
            d. Used for pencil or ink
            e. Can be used for CAD plotting
    B. Paper sizes
        1. Standard U.S. sizes (ANSI)
            a. A - 8.5" x 11"
            b. B - 11" x 17"
            c. C - 17" x 24"
            d. D - 22" x 34"

        - e. E - 34" x 44"
    - 2. International sizes (mm) (ISO)
        - a. A4 - 210 x 297
        - b. A3 - 297 x 420
        - c. A2 - 420 x 594
        - d. A1 - 594 x 841
        - e. A0 - 841 x 1189

II. Drafting Materials

- A. Pencils/pens
    - 1. Leads
        - a. Range from 9H to 7B
        - b. H - hard leads
        - c. B - soft leads
        - d. Most often used: 2H, HB, B
    - 2. Lead holder
    - 3. Mechanical pencil
    - 4. Ink pens
- B. Scales (see B-2 for further instruction)
    - 1. Mechanical/Mechanical Draftsman scale
        - a. Open-divided
        - b. Inch units
    - 2. Engineers/Civil Engineers scale
        - a. Full-divided
        - b. English units
    - 3. Metric scale
- C. Instruments
    - 1. Compass
    - 2. Triangles
        - a. 30°-60°-90°
        - b. 45°-45°-90°
        - c. Adjustable
    - 3. Dividers
- D. Straight-edges
    - 1. Main drafting straight-edge
        - a. T-square
        - b. Parallel-ruling
        - c. Drafting machine
    - 2. French curve
    - 3. Adjustable curve
- E. Miscellaneous
    - 1. Templates
    - 2. Eraser
    - 3. Eraser pad
    - 4. Eraser brush
    - 5. Eraser shield

6. Protractor
7. Lettering guide (see D-4 for further instructions)
8. Drafting tape
9. Lead sharpener/pointer

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Identify types of drafting equipment;
b) Demonstrate proper techniques for using equipment; and,
c) Identify specific usage for equipment.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-B2) dealing with using measuring scales.

CAD-B1-HO
Use Drawing Media and Related Drafting Materials
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Select drawing media; and,
b. Select related drafting materials

Module Outline:

I. Drawing Media
    A. Types
        1. Drawing papers
            a. 100% rag content
            b. White or light cream
            c. For pencil drawing
            d. Can be used for CAD plotting
        2. Ink papers
            a. Similar to 100% rag content paper
            b. Thicker ply: 2-ply, 3-ply, or 4-ply
            c. White
            d. Used for CAD plotting
        3. Tracing papers/vellums
            a. Transparent
            b. Used for reproduction
            c. Used for pencil or ink
            d. Good for blueprinting
        4. Polyester film
            a. Superior material, expensive
            b. Transparent
            c. Easy erasing, no ghost marks
            d. Used for pencil or ink
            e. Can be used for CAD plotting
    B. Paper sizes
        1. Standard U.S. sizes (ANSI)
            a. A - 8.5" x 11"
            b. B - 11" x 17"
            c. C - 17" x 24"
            d. D - 22" x 34"
            e. E - 34" x 44"
        2. International sizes (mm) (ISO)
            a. A4 - 210 x 297
            b. A3 - 297 x 420

            - c. A2 - 420 x 594
            - d. A1 - 594 x 841
            - e. A0 - 841 x 1189

- II. Drafting Materials
    - A. Pencils/pens
        - 1. Leads
            - a. Range from 9H to 7B
            - b. H - hard leads
            - c. B - soft leads
            - d. Most often used: 2H, HB, B
        - 2. Lead holder
        - 3. Mechanical pencil
        - 4. Ink pens
    - B. Scales (see B-2 for further instruction)
        - 1. Mechanical/Mechanical Draftsman scale
            - a. Open-divided
            - b. Inch units
        - 2. Engineers/Civil Engineers scale
            - a. Full-divided
            - b. English units
        - 3. Metric scale
    - C. Instruments
        - 1. Compass
        - 2. Triangles
            - a. 30°-60°-90°
            - b. 45°-45°-90°
            - c. Adjustable
        - 3. Dividers
    - D. Straight-edges
        - 1. Main drafting straight-edge
            - a. T-square
            - b. Parallel-ruling
            - c. Drafting machine
        - 2. French curve
        - 3. Adjustable curve
    - E. Miscellaneous
        - 1. Templates
        - 2. Eraser
        - 3. Eraser pad
        - 4. Eraser brush
        - 5. Eraser shield
        - 6. Protractor
        - 7. Lettering guide (see D-4 for further instructions)
        - 8. Drafting tape
        - 9. Lead sharpener/pointer

CAD-B1-LE
Use Drawing Media and Related Drafting Materials
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:
a) Identify types of drafting equipment;
b) Demonstrate proper techniques for using equipment; and,
c) Identify specific usage for equipment.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-B2

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Demonstrate Fundamental Drafting Skills**
Task: Use Measuring Scales

Objective(s)

Upon completion of this unit the student will be able to:
a. Identify types of scales;
b. Select appropriate scale; and,
c. Use scales to measure and transfer dimensions.

Instructional Materials:

Textbook
Mechanical Engineers scale
Engineers scale (Civil Engineers scale)
Metric scale
MASTER Handout (CAD-B2-HO)
MASTER Laboratory Exercise (CAD-B2-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-B1 "Use Drawing Media and Related Drafting Materials"

Introduction:

Drawings are often drawn at some scale other than full scale because the actual size of the object is too small or large to be easily read and used. Engineering technicians must be completely versed in the use of the three engineers scales: Mechanical Engineers, Engineers scale (Civil Engineers scale), Metric scale.

Presentation Outline:

I. Discuss Types of Scales for Engineering Drawing
    A. Discuss Mechanical Engineers scale
        1. Discuss uses for Mechanical Engineers scale
        2. Discuss open-divided scales
        3. Demonstrate the procedure for measuring lengths at a given scale
        4. Demonstrate the procedure for drawing lines at a specified length at a given scale
    B. Discuss Engineers scale (Civil Engineers scale)
        1. Discuss uses for Engineers scale
        2. Discuss full-divided scales
        3. Demonstrate the procedure for measuring lengths at a given scale
        4. Demonstrate the procedure for drawing lines at a specified length at a given scale
    C. Discuss Metric scale
        1. Discuss uses for Metric scale
        2. Discuss converting between metric units (mm to cm, etc.) with the Metric scale
        3. Demonstrate the procedure for measuring lengths at a given scale
        4. Demonstrate the procedure for drawing lines at a specified length at a given scale

II. Discuss Converting from Inches to Feet Using Mechanical Engineers and Engineers Scales

III. Discuss Converting Distances from English to Metric Units (Inches to MM, MM to Inches, Etc.)

IV. Discuss Drawing Scale
    A. Discuss preferred scales
        1. Inch scales
        2. Metric scales
        3. English scales (in., ft., yd., etc.)
    B. Discuss standard notations for scales

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete worksheets with scaled measurements and scaled drawing using Mechanical Engineers, Engineers, and Metric scales.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-B3) dealing with identifying drafting line styles and weights

CAD-B2-HO
Use Measuring Scales
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

- a. Identify types of scales;
- b. Select appropriate scale; and,
- c. Use scales to measure and transfer dimensions.

Module Outline:

- I. Discuss Types of Scales for Engineering Drawing
  - A. Discuss Mechanical Engineers scale
    - 1. Discuss uses for Mechanical Engineers scale
    - 2. Discuss open-divided scales
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  - B. Discuss Engineers scale (Civil Engineers scale)
    - 1. Discuss uses for Engineers scale
    - 2. Discuss full-divided scales
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  - C. Discuss Metric scale
    - 1. Discuss uses for Metric scale
    - 2. Discuss converting between metric units (mm to cm, etc.) with the Metric scale
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
- II. Discuss Converting from Inches to Feet Using Mechanical Engineers and Engineers Scales
- III. Discuss Converting Distances from English to Metric Units (Inches to MM, MM to Inches, Etc.)
- IV. Discuss Drawing Scale
  - A. Discuss preferred scales
    - 1. Inch scales
    - 2. Metric scales

    3. English scales (in., ft., yd., etc.)

B. Discuss standard notations for scales

CAD-B2-LE
Use Measuring Scales
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete worksheets with scaled measurements and scaled drawing using Mechanical Engineers, Engineers, and Metric scales.

CAD-B3

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-B3

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Demonstrate Fundamental Drafting Skills**
Task: Identify Drafting Line Styles and Weights

Objective(s)

Upon completion of this unit the student will be able to:
a. Identify line styles; and
b. Apply line styles.

Instructional Materials:

Textbook
Drafting materials:
  Pencils (lead pointer, mechanical pencil)
  Various leads (4H to 2B)
  Triangles (30°-60°-90°, 45°-45°-90°, adjustable)
  Paper of various sizes (A, B, C, D, E sizes)
  T-square or parallel-ruling edge or drafting machine
  Eraser
  Drafting tape
MASTER Handout (CAD-B3-HO)
MASTER Laboratory Exercise (CAD-B3-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-B1 “Use Drawing Media and Related Drafting Materials”
CAD-B2 “Use Measuring Scales”

Introduction:

If the language of communication between the designer and the fabricator is the orthographic display of the object, then the most basic element of this language are the lines, which are used to draw the various parts and views of the object.

A mechanical drafter must be fully literate in the alphabet of lines, including proper line types, weights, and when and where to use them.

Presentation Outline:

I. Object Line: Used to Indicate All Visible Edges of an Object
    A. Solid, continuous line
    B. Thick, approximately .032" (0.7mm)
    C. Weight: dark
II. Hidden Line: Used to Show Surfaces or Edges of an Object That are Hidden From View
    A. Short, uniform dashes
    B. Thin, approximately 0.16" (0.35 mm)
    C. Weight: medium
III. Center Line: Used to Show the Center of Holes, Cylinders, Arcs, and Symmetrical Features
    A. Alternate long dash, short dash
    B. Thin, approximately 0.16" (0.35mm)
    C. Weight: light
IV. Section Line: Used to Indicate the Surface in the Section View Imagined to Have Been Cut along the Cutting-Plane Line
    A. Solid, continuous line
    B. Thin, approximately 0.16" (0.35mm)
    C. Weight: light
V. Dimension Line/Extension Line/Leader: Components of Dimensioning
    A. Solid, continuous line
    B. Thin, approximately 0.16" (0.35mm)
    C. Weight: medium
VI. Cutting-Plane Line: Used to Indicate Where an Imaginary Cut Is Made Through an Object in Order to Create a Section View
    A. Two methods:
        1. Alternate long dash, short dash (i.e., hidden line)
        2. Alternate long dash and two short dashes (i.e., phantom line)
    B. Thick, approximately .032" (0.7mm)
    C. Weight: dark
VII. Break Line: Used When it Is Desirable to Shorten the View of a Long Part or Show a Natural Break for a Section View
    A. Freehand break

        1. Freehand line, moderately rough
        2. Thick, approximately 0.32" (0.7mm)
        3. Weight: dark
    B. Long break
        1. Solid, continuous line with regular peaks
        2. Thin, approximately .016 (0.35mm)
        3. Weight: medium

VIII. Phantom Line: Used to Indicate Alternate Positions of Moving Parts, Adjacent Positions of Moving Parts, Adjacent Positions of Related Parts, and Repetitive Details
    A. Alternate long dash and two short dashes
    B. Thin, approximately 0.16" (0.35mm)
    C. Weight: medium

IX. Stitch Line: Used for Indicating a Sewing or Stitching Process
    A. Two methods:
        1. Very short uniform dashes
        2. Uniform dotted line
    B. Thin, approximately 0.16" (0.35mm)
    C. Weight: medium

X. Chain Line: Used to Indicate That a Surface or Zone Is to Receive Additional Treatment or Considerations
    A. Alternate medium dash, very short dash
    B. Thick, approximately .032 (0.7mm)
    C. Weight: medium

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Identify line types;
b) Describe and provide example uses for each line type; and
c) Draw each line type separately and in its proper application.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-B4) dealing with preparing title blocks and other drafting formats.

CAD-B3-HO
Identify Drafting Line Styles and Weights
Attachment 1: **MASTER** Handout

Objective(s)

Upon completion of this unit the student will be able to:

a. Identify types of scales;
b. Select appropriate scale; and,
c. Use scales to measure and transfer dimensions.

Module Outline:

I. Discuss Types of Scales for Engineering Drawing
  A. Discuss Mechanical Engineers scale
    1. Discuss uses for Mechanical Engineers scale
    2. Discuss open-divided scales
    3. Demonstrate the procedure for measuring lengths at a given scale
    4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  B. Discuss Engineers scale (Civil Engineers scale)
    1. Discuss uses for Engineers scale
    2. Discuss full-divided scales
    3. Demonstrate the procedure for measuring lengths at a given scale
    4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  C. Discuss Metric scale
    1. Discuss uses for Metric scale
    2. Discuss converting between metric units (mm to cm, etc.) with the Metric scale
    3. Demonstrate the procedure for measuring lengths at a given scale
    4. Demonstrate the procedure for drawing lines at a specified length at a given scale
II. Discuss Converting from Inches to Feet Using Mechanical Engineers and Engineers Scales
III. Discuss Converting Distances from English to Metric Units (Inches to MM, MM to Inches, Etc.)
IV. Discuss Drawing Scale
  A. Discuss preferred scales
    1. Inch scales
    2. Metric scales

    3. English scales (in., ft., yd., etc.)
B. Discuss standard notations for scales

CAD-B3-LE
Identify Drafting Line Styles and Weights
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Identify line types;

b) Describe and provide example uses for each line type; and

c) Draw each line type separately and in its proper application.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-B4

Subject: **Computer-Aided Drafting & Design** **Time: 2 Hrs.**

Duty: **Demonstrate Fundamental Drafting Skills**
Task: Prepare Title Blocks and Other Drafting Formats

Objective(s)

Upon completion of this unit the student will be able to:
a. Identify and prepare title blocks;
b. Identify and prepare bill of material/parts lists; and,
c. Identify and prepare revision history blocks.

Instructional Materials:

Textbook
Drafting materials:
    Pencils (lead pointer, mechanical pencil)
    Various leads (4H to 2B)
    Triangles (30°-60°-90°, 45°-45°-90°, adjustable)
    Paper of various sizes (A, B, C, D, E sizes)
    T-square or parallel-ruling edge or drafting machine
    Eraser
    Drafting tape
MASTER Handout (CAD-B4-HO)
MASTER Laboratory Exercise (CAD-B4-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-B1 "Use Drawing Media and Related Drafting Materials"
CAD-B2 "Use Measuring Scales"

CAD-B3 "Identify Drafting Line Styles and Weights"

Introduction:

The function of a title block is to show all necessary information not given directly on the drawing with dimensions and notes. The title block must be organized in a standard layout, which may be set within the company or according to national or international standards.

Other types of drawing information, such as the revision history and individual part information, is also contained within separate tables, known respectively as revision blocks and bills of materials or parts lists.

Presentation Outline:

I. Title Blocks
  A. Identify major areas included in a title block
    1. Name of object or assembly
    2. Name of manufacturer
    3. Name of drafter
    4. Name of checker
    5. Name of chief engineer or other supervisor
    6. Scale of the drawing
    7. Drawing number or code
  B. Identify optional areas
    1. Global dimension tolerance specifications
    2. Material type
    3. Manufacturing information, e.g., heat treatment, surface finish, hardness, etc.
    4. Superceding and/or superceded drawing numbers
    5. Other industry-specific information
  C. Draw title blocks of various sizes and orientations
    1. Orientation
      a. Across bottom of sheet (horizontal)
      b. Bottom right corner
      c. Across right size of sheet (vertical)
    2. Minimum letter heights in title block areas (ANSI Y14.2M-1979 (R1987))
      a. Drawing number/code
        (1) .290" (7mm) for drawing sizes larger than 17" x 22"
        (2) .240" (7mm) for drawing sizes equal to or less than 17" x 22"
      b. Drawing title: .240" (7mm) for all drawing sizes
      c. All other title block text:

(1) .140" (5mm) for drawing sizes larger than 17" x 22"
(2) .120" (3.5mm) for drawing sizes equal to or less than 17" x 22

II. Bill of Material/Parts List
A. ***Purpose:*** itemized list of the several parts which comprise the assembly drawing and can be found in detail drawings
B. Location
1. Included on drawing sheet with assembly drawing
a. On top of title block, attached
b. Above title block, attached to border
2. On separate paper (8.5" x 11")
C. Format
1. Each part must have the following information: part number, part name, total number required in the assembly, and material
2. Other information may include: pattern numbers, stock sizes, catalog numbers, weights, nominal dimensions, etc.

III. Revision History Block
A. ***Purpose:*** to provide complete historical information concerning the design and modifications of the part
B. Location
1. Attached to the title block
2. Above title block, attached to border
C. Format
1. Each block must contain the following information: description of the correction or modification, date of revision, supervisor's check area, part number
2. Other information may include: drafter identification, drawing code, etc.

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Draw title blocks of various sizes, shapes, and orientations;
b) Create bills of materials of various sizes, shapes, and orientations; and,
c) Create revision blocks of various sizes, shapes, and orientations.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-B5) dealing with creating technical sketches.

CAD-B4-HO
Prepare Title Blocks and Other Drafting Formats
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

a. Identify and prepare title blocks;
b. Identify and prepare bill of material/parts lists; and,
c. Identify and prepare revision history blocks.

Module Outline:

I. Title Blocks
  A. Identify major areas included in a title block
    1. Name of object or assembly
    2. Name of manufacturer
    3. Name of drafter
    4. Name of checker
    5. Name of chief engineer or other supervisor
    6. Scale of the drawing
    7. Drawing number or code
  B. Identify optional areas
    1. Global dimension tolerance specifications
    2. Material type
    3. Manufacturing information, e.g., heat treatment, surface finish, hardness, etc.
    4. Superceding and/or superceded drawing numbers
    5. Other industry-specific information
  C. Draw title blocks of various sizes and orientations
    1. Orientation
      a. Across bottom of sheet (horizontal)
      b. Bottom right corner
      c. Across right size of sheet (vertical)
    2. Minimum letter heights in title block areas (ANSI Y14.2M-1979 (R1987))
      a. Drawing number/code
        (1) .290" (7mm) for drawing sizes larger than 17" x 22"
        (2) .240" (7mm) for drawing sizes equal to or less than 17" x 22"
      b. Drawing title: .240" (7mm) for all drawing sizes
      c. All other title block text:
        (1) .140" (5mm) for drawing sizes larger than 17" x 22"

(2) .120" (3.5mm) for drawing sizes equal to or less than 17" x 22

II. Bill of Material/Parts List

A. *Purpose:* itemized list of the several parts which comprise the assembly drawing and can be found in detail drawings

B. Location

1. Included on drawing sheet with assembly drawing

a. On top of title block, attached

b. Above title block, attached to border

2. On separate paper (8.5" x 11")

C. Format

1. Each part must have the following information: part number, part name, total number required in the assembly, and material

2. Other information may include: pattern numbers, stock sizes, catalog numbers, weights, nominal dimensions, etc.

III. Revision History Block

A. *Purpose:* to provide complete historical information concerning the design and modifications of the part

B. Location

1. Attached to the title block

2. Above title block, attached to border

C. Format

1. Each block must contain the following information: description of the correction or modification, date of revision, supervisor's check area, part number

2. Other information may include: drafter identification, drawing code, etc.

CAD-B4-LE
Prepare Title Blocks and Other Drafting Formats
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Draw title blocks of various sizes, shapes, and orientations;
b) Create bills of materials of various sizes, shapes, and orientations; and,
c) Create revision blocks of various sizes, shapes, and orientations.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-B5

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Demonstrate Fundamental Drafting Skills**
Task: Create Technical Sketches

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify and create orthographic sketches (single and multiview);
b. Identify and create oblique sketches;
c. Identify and create axonometric sketches (iso-, tri-, and diametric);
d. Identify and create perspective sketches (1, 2, and 3-point); and,
e. Understand and apply techniques of sketching.

Instructional Materials:

Textbook
Drafting materials:
  Pencils (lead pointer, mechanical pencil)
  Various leads (4H to 2B)
  Sketching paper
  Isometric grid paper
  Rectangular grid paper
  Eraser
MASTER Handout (CAD-B5-HO)
MASTER Laboratory Exercise (CAD-B5-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-B1 "Use Drawing Media and Related Drafting Materials"

CAD-B2	"Use Measuring Scales"
CAD-B3	"Identify Drafting Line Styles and Weights"
CAD-B4	"Prepare Title Blocks and Other Drafting Formats"

Introduction:

The ability to accurately create a sketch which describes the initial design concept or describes some aspect of the design is invaluable. All great designs begin with sketches and sketching is still the single quickest way to "flesh" out an idea. It is absolutely critical that mechanical designers know how to sketch accurately and quickly. In this day of computers and CAD, this is a art which will never lose its utility.

Presentation Outline:

- I. Line Work
  - A. Types of sketched lines
    - 1. Construction lines
    - 2. Visible lines
    - 3. Other lines (hidden, center, phantom, etc.)
  - B. Technique of sketching
    - 1. Sketching straight lines
      - a. Drawing vertical lines
      - b. Drawing horizontal lines
      - c. Maintaining proportion
    - 2. Sketching circles, curves and ellipses: Box Method
    - 3. Discuss comparison to artistic sketching
      - a. Typically no shading in technical sketching
      - b. Concerned with maintaining proper proportion and scale
- II. Orthographic Sketches
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a) Three-dimensional object (object to be projected)
      - b) Projection plane
      - c) Projectors
      - d) Projected image of the object: image projected onto the projection plane
    - 2. Representing hidden features
    - 3. Terminology
      - a) Normal surfaces
      - b) Oblique surfaces
      - a) Edges
  - B. Single View Orthographic Sketch
    - 1. Maintain scale and proportion
    - 2. Maintain straightness of lines

    - 3. Use construction lines – "blocking-in the drawing"
  - C. Multiview Orthographic Sketch
    - 1. Discuss the "glass box" analogy
    - 2. Alignment of views
      - a) Six principal views: top, front, right-side, left-side, bottom, back
      - b) Three standard views: top, front, right-side
    - 3. Discuss transferring dimensions between views
- III. Pictorial Sketches
  - A. Types of pictorial sketches
    - 1. Oblique projection
    - 2. Axonometric projection
    - 3. Perspective projection
  - B. Oblique sketches
    - 1. Technique
      - a) Front surface (parallel to viewing plane) drawn "flat"
      - b) All surfaces parallel to front surface drawn "flat"
      - c) Depth projected back on receding, parallel lines
        - (1) Varying angle of receding lines changes viewing position
        - (2) Typical angle is 45° (measured from the right-side horizontal line in the CCW direction.)
      - d) Projection of curves (circles, arcs, ellipses)
        - (1) On front surface and surfaces parallel to front surface: curves are true shape.
        - (2) On other surfaces: circles and circular arcs appear as ellipses.
        - (3) Drawing method: use box method, maintaining angle for receding lines
      - e) Selection of front surface
        - (1) Minimize curves
        - (2) Show most complicated profile
        - (3) Show most detail in front surface
    - 2. Types of oblique sketches
      - a) Cabinet projection: depth drawn at half scale
      - b) Cavalier projection: depth drawn at full scale
  - C. Axonometric sketches
    - 1. Types of axonometric sketches
      - a) Isometric: angles between three axes are equal to 120° (sum = 360°)
      - b) Trimetric: angles between three axes are unequal (sum = 360°)
      - c) Dimetric: angle between two axes are equal (sum = 360°)
    - 2. Technique
      - a) All normal surfaces appear as oblique surfaces

        - b) Receding lines drawn parallel to axonometric axes
        - c) Length of receding lines
            - (1) Isometric scale = 80% true length
            - (2) Ordinary scale = 100% true length (full scale)
        - d) Curves on all surfaces appear as ellipses
        - e) Discuss box construction method
        - f) Discuss using isometric grid paper

D. Perspective sketches

- 1. Types of perspective sketches
    - a) One-point perspective: single vanishing point
    - b) Two-point perspective: two vanishing points
    - c) Three-point perspective: three vanishing points
- 2. Technique
    - a) Components of all perspective drawings
        - (1) Horizon line
            - (a) Discuss function
            - (b) Discuss placement
        - (2) Vanishing points
            - (a) Discuss function
            - (b) Discuss placement
        - (3) Location of object affects viewpoint
            - (a) In relation to horizon line (above, below, on horizon line)
            - (b) In relation to vanishing points (left, right, or center)
        - (4) Length of receding (converging) lines
- 3. One-point perspective
    - a) Discuss similarities to oblique projection
    - b) Vanishing point located on horizon line
    - c) Receding lines converge to vanishing point
    - d) Surfaces parallel to viewing plane drawn "flat" (as in oblique projection)
- 4. Two-point perspective
    - a) Discuss similarities to axonometric projection
    - b) Vanishing points located on horizon line
    - c) Receding lines converge to vanishing points
        - (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
        - (2) Lines projecting to the right viewing plane center project to vanishing point to the right
    - d) Vertical lines project vertically at true length
- 5. Three-point perspective
    - a) Discuss similarities to axonometric projection
    - b) Vanishing point location
        - (1) Two vanishing points located on horizon line,

        - (2) Third vanishing point located above or below horizon line
    - c) Receding lines converge to vanishing points
        - (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
        - (2) Lines projecting to the right viewing plane center project to vanishing point to the right
        - (3) Vertical lines converge to third vanishing point (point not on horizon line)

Practical Application:

Students will be given classwork and homework assignments (in the following order) in which they must:

a) Sketch lines, circles, and curves following proper technical sketching techniques;
b) Sketch simple (three-dimensional and two-dimensional) shapes using single-view orthographic projection;
c) Sketch simple three-dimensional shapes using multiview orthographic projection;
d) Sketch more complicated objects using multiview orthographic projection;
e) Sketch simple three-dimensional objects using oblique projection (cabinet and cavalier);
f) Sketch simple three-dimensional objects using axonometric projection (iso-, tri-, and dimetric);
g) Sketch simple three-dimensional objects using perspective projection (one, two, and three-point); and,
h) Sketch complex three-dimensional objects using a variety of projection methods.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This is the last technical module under Duty B: Demonstrate Fundamental Drafting Skills. The next duty is C: Plan and Organize Activities, and the first **MASTER Technical Module** is CAD-C1 dealing with determining scope of drafting assignment.

CAD-B5-HO
Create Technical Sketches
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify and create orthographic sketches (single and multiview);
- b. Identify and create oblique sketches;
- c. Identify and create axonometric sketches (iso-, tri-, and diametric);
- d. Identify and create perspective sketches (1, 2, and 3-point); and,
- e. Understand and apply techniques of sketching.

Module Outline:

- I. Line Work
  - A. Types of sketched lines
    - 1. Construction lines
    - 2. Visible lines
    - 3. Other lines (hidden, center, phantom, etc.)
  - B. Technique of sketching
    - 1. Sketching straight lines
      - a. Drawing vertical lines
      - b. Drawing horizontal lines
      - c. Maintaining proportion
    - 2. Sketching circles, curves and ellipses: Box Method
    - 3. Discuss comparison to artistic sketching
      - a. Typically no shading in technical sketching
      - b. Concerned with maintaining proper proportion and scale
- II. Orthographic Sketches
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a) Three-dimensional object (object to be projected)
      - b) Projection plane
      - c) Projectors
      - d) Projected image of the object: image projected onto the projection plane
    - 2. Representing hidden features
    - 3. Terminology
      - a) Normal surfaces
      - b) Oblique surfaces
      - a) Edges
  - B. Single View Orthographic Sketch
    - 1. Maintain scale and proportion

2. Maintain straightness of lines
3. Use construction lines – "blocking-in the drawing"
C. Multiview Orthographic Sketch
1. Discuss the "glass box" analogy
2. Alignment of views
a) Six principal views: top, front, right-side, left-side, bottom, back
b) Three standard views: top, front, right-side
3. Discuss transferring dimensions between views
III. Pictorial Sketches
A. Types of pictorial sketches
1. Oblique projection
2. Axonometric projection
3. Perspective projection
B. Oblique sketches
1. Technique
a) Front surface (parallel to viewing plane) drawn "flat"
b) All surfaces parallel to front surface drawn "flat"
c) Depth projected back on receding, parallel lines
(1) Varying angle of receding lines changes viewing position
(2) Typical angle is 45° (measured from the right-side horizontal line in the CCW direction.)
d) Projection of curves (circles, arcs, ellipses)
(1) On front surface and surfaces parallel to front surface: curves are true shape.
(2) On other surfaces: circles and circular arcs appear as ellipses.
(3) Drawing method: use box method, maintaining angle for receding lines
e) Selection of front surface
(1) Minimize curves
(2) Show most complicated profile
(3) Show most detail in front surface
2. Types of oblique sketches
a) Cabinet projection: depth drawn at half scale
b) Cavalier projection: depth drawn at full scale
C. Axonometric sketches
1. Types of axonometric sketches
a) Isometric: angles between three axes are equal to 120° (sum = 360°)
b) Trimetric: angles between three axes are unequal (sum = 360°)
c) Dimetric: angle between two axes are equal (sum = 360°)
2. Technique

- a) All normal surfaces appear as oblique surfaces
- b) Receding lines drawn parallel to axonometric axes
- c) Length of receding lines
  - (1) Isometric scale = 80% true length
  - (2) Ordinary scale = 100% true length (full scale)
- d) Curves on all surfaces appear as ellipses
- e) Discuss box construction method
- f) Discuss using isometric grid paper

- D. Perspective sketches
  - 1. Types of perspective sketches
    - a) One-point perspective: single vanishing point
    - b) Two-point perspective: two vanishing points
    - c) Three-point perspective: three vanishing points
  - 2. Technique
    - a) Components of all perspective drawings
      - (1) Horizon line
        - (a) Discuss function
        - (b) Discuss placement
      - (2) Vanishing points
        - (a) Discuss function
        - (b) Discuss placement
      - (3) Location of object affects viewpoint
        - (a) In relation to horizon line (above, below, on horizon line)
        - (b) In relation to vanishing points (left, right, or center)
      - (4) Length of receding (converging) lines
  - 3. One-point perspective
    - a) Discuss similarities to oblique projection
    - b) Vanishing point located on horizon line
    - c) Receding lines converge to vanishing point
    - d) Surfaces parallel to viewing plane drawn "flat" (as in oblique projection)
  - 4. Two-point perspective
    - a) Discuss similarities to axonometric projection
    - b) Vanishing points located on horizon line
    - c) Receding lines converge to vanishing points
      - (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
      - (2) Lines projecting to the right viewing plane center project to vanishing point to the right
    - d) Vertical lines project vertically at true length
  - 5. Three-point perspective
    - a) Discuss similarities to axonometric projection
    - b) Vanishing point location

    - (1) Two vanishing points located on horizon line,
    - (2) Third vanishing point located above or below horizon line
- c) Receding lines converge to vanishing points
    - (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
    - (2) Lines projecting to the right viewing plane center project to vanishing point to the right
    - (3) Vertical lines converge to third vanishing point (point not on horizon line)

CAD-B5-LE
Create Technical Sketches
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments (in the following order) in which they must:

a) **Sketch lines, circles, and curves following proper technical sketching techniques;**

b) **Sketch simple (three-dimensional and two-dimensional) shapes using single-view orthographic projection;**

c) **Sketch simple three-dimensional shapes using multiview orthographic projection;**

d) **Sketch more complicated objects using multiview orthographic projection;**

e) **Sketch simple three-dimensional objects using oblique projection (cabinet and cavalier);**

f) **Sketch simple three-dimensional objects using axonometric projection (iso-, tri-, and dimetric);**

g) **Sketch simple three-dimensional objects using perspective projection (one, two, and three-point); and,**

h) **Sketch complex three-dimensional objects using a variety of projection methods.**

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

CAD-C1

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-C1

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Plan And Organize Activities**
Task: Determine Scope of Drafting Assignment

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand completion date;
b. Identify number of drawings to be completed;
c. Identify assignment requirements; and,
d. Understand drawing responsibilities.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-C1-HO)
MASTER Laboratory Exercise (CAD-C1-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-B1	"Use Drawing Media and Related Drafting Materials"
CAD-B2	"Use Measuring Scales"
CAD-B3	"Identify Drafting Line Styles and Weights"
CAD-B4	"Prepare Title Blocks and Other Drafting Formats"

Introduction:

CAD drafters and designers typically must interact with many different departments, such as engineers, designers, other drafters, purchasing, manufacturing, and marketing. Each area will make its own demands on the drafter and he must be able to complete the required work within the allotted time frame or the entire team will be made to suffer the consequences.

The first step is to determine the scope of the drafting assignment. That is, what exactly is required, who must be involved, when is the completion date, and what is the make-up of the work team (superiors and colleagues).

Presentation Outline:

I. Discuss Mechanical Drafting Project Requirements
    A. Discuss the expected date of completion
    B. Discuss the specific requirements of the project
        1. Discuss the number of drawings that are required to be completed on the completion date
        2. Discuss the format for the drawings
            a. Determine whether the drawings must be CAD or manual drawings
            b. Determine the type of paper (bond, film, etc.)
            c. Determine the need for blueprint/reproduction
            d. Determine the desired paper size
            e. Determine the desired drawing scale
II. Discuss Additional Assignment Requirements

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Complete the drafting assignment following requirements discussed above.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-C2) dealing with selecting appropriate drafting techniques for drawings.

CAD-C1-HO
Determine Scope of Drafting Assignment
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand completion date;
b. Identify number of drawings to be completed;
c. Identify assignment requirements; and,
d. Understand drawing responsibilities.

Module Outline:

I. Discuss Mechanical Drafting Project Requirements
    A. Discuss the expected date of completion
    B. Discuss the specific requirements of the project
        1. Discuss the number of drawings that are required to be completed on the completion date
        2. Discuss the format for the drawings
            a. Determine whether the drawings must be CAD or manual drawings
            b. Determine the type of paper (bond, film, etc.)
            c. Determine the need for blueprint/reproduction
            d. Determine the desired paper size
            e. Determine the desired drawing scale
II. Discuss Additional Assignment Requirements

CAD-C1-LE

Determine Scope of Drafting Assignment

Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete the drafting assignment following requirements discussed above.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-C2

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Plan And Organize Activities**
Task: Select Appropriate Drafting Techniques for Drawings

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of drawings required; and,
b. Identify types of materials needed.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-C2-HO)
MASTER Laboratory Exercise (CAD-C2-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-B1	"Use Drawing Media and Related Drafting Materials"
CAD-B2	"Use Measuring Scales"
CAD-B3	"Identify Drafting Line Styles and Weights"
CAD-B4	"Prepare Title Blocks and Other Drafting Formats"
CAD-C1	"Determine Scope of Drafting Assignment"

Introduction:

Once the scope of the drafting assignment has been determined, the drafter must select the appropriate drafting techniques that he will use in order to complete the assignment. This includes the types of drawing and sketches necessary and suitable materials for the work.

Presentation Outline:

I. Discuss Types of Drawings Required
   A. Working drawing set
   B. Technical sketch
   C. Mechanical drawing
   D. Assembly drawing
II. Discuss Required Drawing Process
   A. CAD drawing
   B. Manual drawing
   C. Technical sketch
III. Discuss Desired Standard
   A. Industry standard
   B. National – ANSI
   C. International – ISO
   D. Other (Japanese, military, etc.)
IV. Discuss Required Supporting Materials
   A. Determine which parts catalogs are necessary
   B. Determine which reference books are necessary (e.g. *Machinery's Handbook*, ANSI standards)
   C. Determine which additional supporting materials are required

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Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Complete the drafting assignment following requirements discussed above.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

- **MASTER Technical Module (CAD-C3)** dealing with maintaining supporting documents.

CAD-C2-HO
Select Appropriate Drafting Techniques for Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of drawings required; and,
b. Identify types of materials needed.

Module Outline:

I. Discuss Types of Drawings Required
  A. Working drawing set
  B. Technical sketch
  C. Mechanical drawing
  D. Assembly drawing
II. Discuss Required Drawing Process
  A. CAD drawing
  B. Manual drawing
  C. Technical sketch
III. Discuss Desired Standard
  A. Industry standard
  B. National – ANSI
  C. International – ISO
  D. Other (Japanese, military, etc.)
IV. Discuss Required Supporting Materials
  A. Determine which parts catalogs are necessary
  B. Determine which reference books are necessary (e.g. *Machinery's Handbook*, ANSI standards)
  C. Determine which additional supporting materials are required

CAD-C2-LE
Select Appropriate Drafting Techniques for Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete the drafting assignment following requirements discussed above.

CAD-C3

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-C3

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Plan And Organize Activities**
Task: Maintain Supporting Documents

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify supporting documents involved;
- b. Understand document filing system; and,
- c. Understand document responsibilities.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-C3-HO)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-B1	"Use Drawing Media and Related Drafting Materials"
CAD-B2	"Use Measuring Scales"
CAD-B3	"Identify Drafting Line Styles and Weights"
CAD-B4	"Prepare Title Blocks and Other Drafting Formats"
CAD-C1	"Determine Scope of Drafting Assignment"
CAD-C2	"Select Appropriate Drafting Techniques for Drawings"

Introduction:

Because there are many aspects of a design and they are often complex and interwoven with other areas and assignments, it is crucial that proper maintenance of supporting documents be a priority. This includes drawings, both on paper and computer disk, and all written documentation and notes pertaining to the task. This is necessary for many reasons, not least of which is legal necessity and revision work.

Presentation Outline:

- I. Discuss Supporting Documents Necessary for Mechanical Design
  - A. Mechanical drawings
    - 1. Detail drawings
    - 2. Manufacturing/production drawings
    - 3. Assembly drawings
  - B. Technical sketches
  - C. Copies of drawings (blueprints, microfilm, etc.)
  - D. Computer files on disk (hard disk, floppy disk, digital tape, CD, etc.)
    - 1. Drawings
    - 2. Documents
    - 3. Other (multimedia, web-based, etc.)
  - E. Bill of materials (if separate from assembly drawing)
  - F. Engineering work sheets: work detailing the equations and assumptions made in order to determine the proper working parameters and characteristics of the machine
  - G. Conceptual design work sheets: details and notes for the conceptual design stage of the design process
  - H. Miscellaneous notes
  - I. Work orders, time sheets, administrative documents
  - J. Supporting vendor pages/information: information from the supplier for various purchased parts used in the design of the machine
- II. Discuss Filing System for Support Documents
  - A. Discuss standardized coding system
    - 1. Same codes link all supporting documents
    - 2. Typically all codes indexed in large database
    - 3. Codes should include information about type of document (e.g. use D for drawings, W for engineering work sheets, V for vendor pages, etc.)
  - B. Discuss use of file codes on drawings
    - 1. Codes listed in title block
    - 2. Codes correspond to work order codes
    - 3. Codes are standardized within industry/company
    - 4. Codes are indexed with other supporting documents
    - 5. Codes are also used as file names when storing drawing files on the computer

Practical Application:

Students will be given classwork and homework assignments in which they must answer review questions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This is the last technical module under Duty C: Plan And Organize Activities. The next duty is D: Prepare Mechanical Production Drawings, and the first **MASTER Technical Module is CAD-D1** dealing with understanding and applying mechanical drawing methods.

CAD-C3-HO
Maintain Supporting Documents
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify supporting documents involved;
b. Understand document filing system; and,
c. Understand document responsibilities.

Module Outline:

I. Discuss Supporting Documents Necessary for Mechanical Design
  A. Mechanical drawings
    1. Detail drawings
    2. Manufacturing/production drawings
    3. Assembly drawings
  B. Technical sketches
  C. Copies of drawings (blueprints, microfilm, etc.)
  D. Computer files on disk (hard disk, floppy disk, digital tape, CD, etc.)
    1. Drawings
    2. Documents
    3. Other (multimedia, web-based, etc.)
  E. Bill of materials (if separate from assembly drawing)
  F. Engineering work sheets: work detailing the equations and assumptions made in order to determine the proper working parameters and characteristics of the machine
  G. Conceptual design work sheets: details and notes for the conceptual design stage of the design process
  H. Miscellaneous notes
  I. Work orders, time sheets, administrative documents
  J. Supporting vendor pages/information: information from the supplier for various purchased parts used in the design of the machine

II. Discuss Filing System for Support Documents
  A. Discuss standardized coding system
    1. Same codes link all supporting documents
    2. Typically all codes indexed in large database
    3. Codes should include information about type of document (e.g. use D for drawings, W for engineering work sheets, V for vendor pages, etc.)
  B. Discuss use of file codes on drawings
    1. Codes listed in title block
    2. Codes correspond to work order codes

3. Codes are standardized within industry/company
4. Codes are indexed with other supporting documents
5. Codes are also used as file names when storing drawing files on the computer

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... **plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.**

Duties		Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splines, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

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CAD-D1

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D1

Subject: **Computer-Aided Drafting & Design** **Time: 30 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Understand and Apply Mechanical Drawing Methods

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand and apply multiview orthographic projection;
b. Understand and apply section views; and,
c. Understand and apply auxiliary views.

Instructional Materials:

Textbook (see References for suitable texts)
CAD software
MASTER Handout (CAD-D1-HO)
MASTER Laboratory Exercise (CAD-D1-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-B1	"Use Drawing Media and Related Drafting Materials"
CAD-B2	"Use Measuring Scales"
CAD-B3	"Identify Drafting Line Styles and Weights"
CAD-B4	"Prepare Title Blocks and Other Drafting Formats"
CAD-B5	"Create Technical Sketches"

Introduction:

Orthographic projection is the basis for all mechanical drawing. The student must be proficient in this drawing style and be able to move comfortably between the "real" world of three dimensions and the two-dimensional world of orthographic projection.

It is not uncommon for students to have trouble visualizing and completely understanding the objects that are projected orthographically. However, this is a crucial skill that must be properly learned in order to move forward. Therefore, this module should be viewed as a critical step in the development of the student as a CAD Technician, and the instructor should be careful to explain each topic fully and watch for students that are having trouble. It is better to catch these troubles early than later. The key to effective learning at this stage is repetition and a gradual increase in the difficulty associated with understanding the drawings.

Presentation Outline:

- I. Orthographic Projection
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a. Three-dimensional object (object to be projected)
      - b. Projection plane
      - c. Projectors
      - d. Projected image of the object
    - 2. Representing hidden features
    - 3. Terminology
      - a. Normal surface
      - b. Oblique surface
      - c. Edge
  - B. Multiview orthographic projection
    - 1. Discuss the "glass box" analogy
    - 2. Six principal views: top, front, right-side, left-side, bottom, back
    - 3. Three standard views: top, front, right-side
    - 4. Discuss transferring dimensions between views
    - 5. Discuss selection and positioning of views
      - a. Clearly show contours, shapes, and features of object
      - b. Choosing a front view
        - (1) Minimize hidden lines
        - (2) Main focal point in drawing
        - (3) Relationship to other views
      - c. Selecting additional views
  - C. Standard rules and conventions
    - 1. Linetypes
      - a. Discuss types used (object, hidden, center, phantom, etc.)

      - b. Precedence of lines: (in order of priority) object, hidden, center, phantom (tie)
    - 2. Explain the use and application of partial views
    - 3. Explain the use and application of revolution conventions
    - 4. Discuss drafting techniques
      - a. Representing surfaces, edges, and corners in various views
      - b. Transferring curves between views
      - c. Fillets and rounds
      - d. Runouts
    - 5. Intersections and tangencies between surfaces and edges
      - a. Cylindrical
      - b. Rectangular

- II. Section Views
  - A. Define ***section view:*** an orthographic view of an object in which an imaginary slice has been made through the object thus exposing the internal features.
  - B. Discuss the proper application of the cutting-plane line (CPL)
    - 1. Purpose: to show the path along which the object has been sliced
    - 2. Placement: the CPL is always placed in the unsectioned view adjacent to the section view
    - 3. Line type - a CPL can be a line made up of short dashes (e.g., a hidden line) or made up of a long dash separated by two short dashes (e.g., a phantom line). It should be as thick as object lines.
    - 4. Arrow direction - the arrows of a CPL are always at right angles to body of the line and always point in the line of sight for viewing the section view
    - 5. Precedence over other line types - the CPL has equal precedence to the center-line
  - C. Section lining
    - 1. Styles - ANSI standard and alternate styles
    - 2. Angle of section lines
      - a. Solitary object - 45°
      - b. Objects in assembly with mating surfaces - alternate angles
    - 3. Alternate section lining (for thin features)
  - D. Standard rules and conventions
    - 1. No hidden lines
    - 2. Maintain orthographic projection
    - 3. Discuss the sectioning of thin features (ribs, webs, etc.)
    - 4. Discuss cylindrical features in section (shafts, bolts, screws, pins, etc.)

  5. Aligned sections (aligning features parallel to the projection plane)
  6. Partial views

E. Types of section views
  1. Full section
  2. Half section
  3. Revolved section
  4. Removed section
  5. Offset section
  6. Broken-out section

F. Conventional breaks
  1. Round objects
  2. Rectangular objects

III. Auxiliary Views

A. Definitions
  1. ***Primary auxiliary views:*** an orthographic view parallel to one of the principal planes of projection and inclined to the other two
  2. ***Secondary auxiliary views:*** an orthographic view projected from an another auxiliary view; an orthographic view that is inclined to all principal views

B. Projecting onto the auxiliary plane
  1. Placement of the auxiliary plane - parallel to the edge-view of the surface to be shown as true shape in the auxiliary view
  2. Projectors from the source view are perpendicular to the auxiliary plane
  3. Discuss how projector distances are measured in the auxiliary view
  4. Discuss how arcs, circles, and curves are projected into the auxiliary view

C. Classification
  1. Depth auxiliary views
  2. Height auxiliary views
  3. Width auxiliary views

D. Standard rules and conventions
  1. Discuss the use of partial auxiliary views
  2. Discuss rules and conventions for hidden lines in auxiliary views
  3. Discuss auxiliary section views

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Choose the correct orthographically projected object given the isometric projection;
b) Choose the correct isometrically projected object given the orthographic projection;
c) Identify similar edges and surfaces between multiple views of an orthographically projected object;
d) Complete the orthographic view of an object given at least two other orthographic views;
e) Create a three-view orthographic projection of an object given the isometric projection; and,
f) Answer review questions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D2) dealing with creating detail drawings.

CAD-D1-HO
Understand and Apply Mechanical Drawing Methods
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand and apply multiview orthographic projection;
- b. Understand and apply section views; and,
- c. Understand and apply auxiliary views.

Module Outline:

- I. Orthographic Projection
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a. Three-dimensional object (object to be projected)
      - b. Projection plane
      - c. Projectors
      - d. Projected image of the object
    - 2. Representing hidden features
    - 3. Terminology
      - a. Normal surface
      - b. Oblique surface
      - c. Edge
  - B. Multiview orthographic projection
    - 1. Discuss the "glass box" analogy
    - 2. Six principal views: top, front, right-side, left-side, bottom, back
    - 3. Three standard views: top, front, right-side
    - 4. Discuss transferring dimensions between views
    - 5. Discuss selection and positioning of views
      - a. Clearly show contours, shapes, and features of object
      - b. Choosing a front view
        - (1) Minimize hidden lines
        - (2) Main focal point in drawing
        - (3) Relationship to other views
      - c. Selecting additional views
  - C. Standard rules and conventions
    - 1. Linetypes
      - a. Discuss types used (object, hidden, center, phantom, etc.)
      - b. Precedence of lines: (in order of priority) object, hidden, center, phantom (tie)
    - 2. Explain the use and application of partial views
    - 3. Explain the use and application of revolution conventions

        4. Discuss drafting techniques
            a. Representing surfaces, edges, and corners in various views
            b. Transferring curves between views
            c. Fillets and rounds
            d. Runouts
        5. Intersections and tangencies between surfaces and edges
            a. Cylindrical
            b. Rectangular

II. Section Views
    A. Define *section view:* an orthographic view of an object in which an imaginary slice has been made through the object thus exposing the internal features.
    B. Discuss the proper application of the cutting-plane line (CPL)
        1. Purpose: to show the path along which the object has been sliced
        2. Placement: the CPL is always placed in the unsectioned view adjacent to the section view
        3. Line type - a CPL can be a line made up of short dashes (e.g., a hidden line) or made up of a long dash separated by two short dashes (e.g., a phantom line). It should be as thick as object lines.
        4. Arrow direction - the arrows of a CPL are always at right angles to body of the line and always point in the line of sight for viewing the section view
        5. Precedence over other line types - the CPL has equal precedence to the center-line
    C. Section lining
        1. Styles - ANSI standard and alternate styles
        2. Angle of section lines
            a. Solitary object - 45°
            b. Objects in assembly with mating surfaces - alternate angles
        3. Alternate section lining (for thin features)
    D. Standard rules and conventions
        1. No hidden lines
        2. Maintain orthographic projection
        3. Discuss the sectioning of thin features (ribs, webs, etc.)
        4. Discuss cylindrical features in section (shafts, bolts, screws, pins, etc.)
        5. Aligned sections (aligning features parallel to the projection plane)
        6. Partial views
    E. Types of section views
        1. Full section

2. Half section
3. Revolved section
4. Removed section
5. Offset section
6. Broken-out section

F. Conventional breaks
1. Round objects
2. Rectangular objects

III. Auxiliary Views

A. Definitions
1. ***Primary auxiliary views:*** an orthographic view parallel to one of the principal planes of projection and inclined to the other two
2. ***Secondary auxiliary views:*** an orthographic view projected from an another auxiliary view; an orthographic view that is inclined to all principal views

B. Projecting onto the auxiliary plane
1. Placement of the auxiliary plane - parallel to the edge-view of the surface to be shown as true shape in the auxiliary view
2. Projectors from the source view are perpendicular to the auxiliary plane
3. Discuss how projector distances are measured in the auxiliary view
4. Discuss how arcs, circles, and curves are projected into the auxiliary view

C. Classification
1. Depth auxiliary views
2. Height auxiliary views
3. Width auxiliary views

D. Standard rules and conventions
1. Discuss the use of partial auxiliary views
2. Discuss rules and conventions for hidden lines in auxiliary views
3. Discuss auxiliary section views

CAD-D1-LE

Understand and Apply Mechanical Drawing Methods

Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Choose the correct orthographically projected object given the isometric projection;

b) Choose the correct isometrically projected object given the orthographic projection;

c) Identify similar edges and surfaces between multiple views of an orthographically projected object;

d) Complete the orthographic view of an object given at least two other orthographic views;

e) Create a three-view orthographic projection of an object given the isometric projection; and,

f) Answer review questions.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D2

Subject: **Computer-Aided Drafting & Design** **Time: 14 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Create Detail Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand and apply detail drawing methods;
b. Identify types of detail drawings;
c. Understand layout of detail drawings;
d. Identify individual parts for detailing;
e. Understand role of the manufacturing process in the detail drawings; and,
f. Identify part dimensions from drawings.

Instructional Materials:

Textbook (see References for suitable texts)
CAD software
MASTER Handout (CAD-D2-HO)
MASTER Laboratory Exercise (CAD-D2-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 "Understand and Apply Mechanical Drawing Methods"

Introduction:

In the design of mechanical devices, from simple tools to complex machines like tractors and cars, the designers will create a working drawing set. This set of drawings contains all the information necessary to build the device. This includes all the required manufacturing processes and assembly steps. The drawing set is typically composed of an assembly drawing showing the final configuration of the device, and a number of detail drawings which are specific drawings of all the individual parts which make up the final device. A small number of parts may be omitted from the detail drawings if they are purchased from outside vendors.

Presentation Outline:

- I. Define ***Detail Drawing:*** Drawing Which Supplies Information for the Manufacture of an Individual Part
- II. Discuss Need for Detail Drawing
  - A. Discuss shape description (drawing geometry) for individual parts
    - 1. Discuss proper view selection
    - 2. Discuss proper view type (section, auxiliary, etc.)
  - B. Discuss size description (dimensions) for individual parts
    - 1. Discuss influence of manufacturing process
    - 2. Include limits and tolerances
  - C. Discuss specifications
    - 1. General notes
    - 2. Manufacturing notes
    - 3. Material specifications
- III. Apply Limits and Tolerances to Detail Drawing
  - A. Discuss application of geometric dimensioning and tolerancing (GD&T) for each type of manufacturing process
  - B. Discuss application of dimensional limits and tolerancing for each type of manufacturing process
  - C. Discuss application of appropriate fit specifications
  - D. Where appropriate, check fit between mating parts
- IV. Understand Standard Detail Drawing Guidelines for Each Manufacturing Processes
  - A. Machining drawing
  - B. Casting drawing
  - C. Forging drawing
  - D. Forming (sheet metal) drawing
  - E. Welding drawing

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create a detail drawing of a specified part given information such as dimensions, manufacturing process, assembly parameters, and limits and fits. Detail drawing assignments should progress systematically by increasing the complexity in logical steps;
For example:
   (1) The first assignment may focus on drawing with proper view selection and dimensions;
   (2) The second assignment should include dimensional limits and fits; and,
   (3) The next assignments should increase the difficulty further by adding GD&T specifications and incorporating manufacturing process information.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D3) dealing with creating assembly drawings.

CAD-D2-HO
Create Detail Drawings
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand and apply detail drawing methods;
b. Identify types of detail drawings;
c. Understand layout of detail drawings;
d. Identify individual parts for detailing;
e. Understand role of the manufacturing process in the detail drawings; and,
f. Identify part dimensions from drawings.

Module Outline:

I. Define *Detail Drawing:* Drawing Which Supplies Information for the Manufacture of an Individual Part
II. Discuss Need for Detail Drawing
  A. Discuss shape description (drawing geometry) for individual parts
    1. Discuss proper view selection
    2. Discuss proper view type (section, auxiliary, etc.)
  B. Discuss size description (dimensions) for individual parts
    1. Discuss influence of manufacturing process
    2. Include limits and tolerances
  C. Discuss specifications
    1. General notes
    2. Manufacturing notes
    3. Material specifications
III. Apply Limits and Tolerances to Detail Drawing
  A. Discuss application of geometric dimensioning and tolerancing (GD&T) for each type of manufacturing process
  B. Discuss application of dimensional limits and tolerancing for each type of manufacturing process
  C. Discuss application of appropriate fit specifications
  D. Where appropriate, check fit between mating parts
IV. Understand Standard Detail Drawing Guidelines for Each Manufacturing Processes
  A. Machining drawing
  B. Casting drawing
  C. Forging drawing
  D. Forming (sheet metal) drawing
  E. Welding drawing

CAD-D2-LE
Create Detail Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create a detail drawing of a specified part given information such as dimensions, manufacturing process, assembly parameters, and limits and fits. Detail drawing assignments should progress systematically by increasing the complexity in logical steps;
   For example:
   (1) The first assignment may focus on drawing with proper view selection and dimensions;
   (2) The second assignment should include dimensional limits and fits; and,
   (3) The next assignments should increase the difficulty further by adding GD&T specifications and incorporating manufacturing process information.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D3

Subject: **Computer-Aided Drafting & Design** **Time: 14 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Create Assembly Drawings

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of assembly drawings;
b. Understand and apply appropriate assembly drawing layout; and,
c. Understand and apply assembly drawing practices.

Instructional Materials:

Textbook (see References for suitable texts)
CAD software
MASTER Handout (CAD-D3-HO)
MASTER Laboratory Exercise (CAD-D3-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-D1 "Understand and Apply Mechanical Drawing Methods"
CAD-D2 "Create Detail Drawings"

Introduction:

The final drawing in a mechanical drawing set is an assembly drawing. The assembly drawing is critical because it shows the final appearance of the machine or mechanism, as well as important features such as proper orientation and dimensions necessary for proper installation. Often the assembly drawing is completed last, after the individual parts are detailed, and typically shows the mechanism without the use of hidden lines. Section views are quite common and are useful for exposing interior parts. For more complicated mechanism, exploded views are used.

Presentation Outline:

- I. Define ***Assembly Drawing:*** A Drawing Which Shows the Machine or Mechanism in its Assembled State
- II. Discuss Purpose of Assembly Drawing
  - A. Show machine or mechanism in assembled state
  - B. Show relationship of various parts to one another
  - C. Provide designation and documentation of each individual part
  - D. Provide overall size dimensions
    - 1. Capacity dimensions
    - 2. Range-of-motion dimensions
    - 3. Mating part dimensions
  - E. Show order of installation for specific parts
- III. Discuss Types of Assembly Drawings
  - A. Design assembly drawings
    - 1. Part of set of drawings comprising detail drawings of individual parts and assembly drawing.
    - 2. Types:
      - a. Orthographic assembly drawing - standard multiview or exploded view
      - b. Pictorial assembly drawing (isometric or oblique) - standard or exploded view
      - c. Sub-assembly drawing - orthographic or pictorial (same as master assembly drawing)
  - B. Installation assembly drawings
    - 1. Assembly drawing which graphically shows order of assembly
    - 2. Exploded orthographic or pictorial drawing
  - C. Catalog assembly drawings
    - 1. Used to graphically describe machine or mechanism for cataloging purposes
    - 2. Provides dimensions critical to design specification
    - 3. Shows object in operating configuration
    - 4. Orthographic or pictorial drawing (unexploded)
- IV. Discuss Standard Rules for Assembly Drawings
  - A. Discuss view selection
    - 1. Include orthographic (regular and auxiliary) and partial views
    - 2. Views must show assembly in proper operating configuration
    - 3. Should focus on function of assembly not the description of individual shapes of parts

    4. Use the minimum number of views/partial views necessary to describe assembly
- B. Discuss use of section views
    1. Hidden lines typically omitted unless needed for clarity
    2. Section views often required to show interior parts/detail
- C. Discuss application of dimensions
    1. Size description of individual part is unnecessary in the assembly drawing
    2. Dimensions generally omitted in assembly drawings
        a. Special case: detail assembly drawing
            (1) Drawing combines the detail description (size and shape) of individual parts with the assembly drawing
            (2) Restricted to simple assemblies
            (3) Corresponding separate detail drawings of parts unnecessary
    3. If needed, typical dimensions consist of:
        a. Overall size of assembled unit
        b. Dimensions used to provide description for parts mating to assembled unit
        c. Indicate maximum/minimum ranges-of-motion of special features of assembled unit
        d. Post-assembly operation is required (e.g., machining)
- D. Discuss practice of part identification
    1. Individual parts are identified with part numbers inside balloons attached to leaders
        a. Leaders never cross
        b. Balloons arranged in rows or columns on drawing
    2. Each part must have a part number
    3. Identical parts use same part number
    4. Parts are listed in the bill of materials (BOM) also known as a parts list (see Module CAD-D5: Create Bill of Materials/Parts List)
- E. Discuss miscellaneous rules and guidelines
    1. Use phantom lines for features drawn showing range-of-motion
    2. Discuss alternate methods for identifying part numbers
    3. Discuss application of assembly drawing and detail drawings on same drawing sheet

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Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create an assembly drawing given the detail. The detail drawings could have been completed in a previous assignment or from another source. If time permits, multiple assembly drawings should be drawn using progressively more difficult drawings. Include orthographic, exploded and detail assembly drawings.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D4) dealing with technical lettering.

CAD-D3-HO
Create Assembly Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of assembly drawings;
b. Understand and apply appropriate assembly drawing layout; and,
c. Understand and apply assembly drawing practices.

Module Outline:

I. Define *Assembly Drawing:* A Drawing Which Shows the Machine or Mechanism in its Assembled State
II. Discuss Purpose of Assembly Drawing
    A. Show machine or mechanism in assembled state
    B. Show relationship of various parts to one another
    C. Provide designation and documentation of each individual part
    D. Provide overall size dimensions
        1. Capacity dimensions
        2. Range-of-motion dimensions
        3. Mating part dimensions
    E. Show order of installation for specific parts
III. Discuss Types of Assembly Drawings
    A. Design assembly drawings
        1. Part of set of drawings comprising detail drawings of individual parts and assembly drawing.
        2. Types:
            a. Orthographic assembly drawing - standard multiview or exploded view
            b. Pictorial assembly drawing (isometric or oblique) - standard or exploded view
            c. Sub-assembly drawing - orthographic or pictorial (same as master assembly drawing)
    B. Installation assembly drawings
        1. Assembly drawing which graphically shows order of assembly
        2. Exploded orthographic or pictorial drawing
    C. Catalog assembly drawings
        1. Used to graphically describe machine or mechanism for cataloging purposes
        2. Provides dimensions critical to design specification
        3. Shows object in operating configuration
        4. Orthographic or pictorial drawing (unexploded)

IV. Discuss Standard Rules for Assembly Drawings

- A. Discuss view selection
  - 1. Include orthographic (regular and auxiliary) and partial views
  - 2. Views must show assembly in proper operating configuration
  - 3. Should focus on function of assembly not the description of individual shapes of parts
  - 4. Use the minimum number of views/partial views necessary to describe assembly
- B. Discuss use of section views
  - 1. Hidden lines typically omitted unless needed for clarity
  - 2. Section views often required to show interior parts/detail
- C. Discuss application of dimensions
  - 1. Size description of individual part is unnecessary in the assembly drawing
  - 2. Dimensions generally omitted in assembly drawings
    - a. Special case: detail assembly drawing
      - (1) Drawing combines the detail description (size and shape) of individual parts with the assembly drawing
      - (2) Restricted to simple assemblies
      - (3) Corresponding separate detail drawings of parts unnecessary
  - 3. If needed, typical dimensions consist of:
    - a. Overall size of assembled unit
    - b. Dimensions used to provide description for parts mating to assembled unit
    - c. Indicate maximum/minimum ranges-of-motion of special features of assembled unit
    - d. Post-assembly operation is required (e.g., machining)
- D. Discuss practice of part identification
  - 1. Individual parts are identified with part numbers inside balloons attached to leaders
    - a. Leaders never cross
    - b. Balloons arranged in rows or columns on drawing
  - 2. Each part must have a part number
  - 3. Identical parts use same part number
  - 4. Parts are listed in the bill of materials (BOM) also known as a parts list (see Module CAD-D5: Create Bill of Materials/Parts List)
- E. Discuss miscellaneous rules and guidelines
  - 1. Use phantom lines for features drawn showing range-of-motion
  - 2. Discuss alternate methods for identifying part numbers
  - 3. Discuss application of assembly drawing and detail drawings on same drawing sheet

CAD-D3-LE
Create Assembly Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create an assembly drawing given the detail. The detail drawings could have been completed in a previous assignment or from another source. If time permits, multiple assembly drawings should be drawn using progressively more difficult drawings. Include orthographic, exploded and detail assembly drawings.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D4

Subject: **Computer-Aided Drafting & Design** **Time: 3 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Perform Technical Lettering

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand technical lettering styles;
b. Identify and apply technical lettering styles; and,
c. Identify and apply standard notations.

Instructional Materials:

Textbook
Drafting pencil (lead pointer or mechanical pencil)
Pencil leads: soft (F, 2B) and hard (H, HB)
Triangle
T-square or parallel-ruling edge or drafting machine
Ames lettering guide
Eraser (white, vinyl, or gum)
Paper (preferably high cotton content)
MASTER Handout (CAD-D4-HO)
MASTER Laboratory Exercise (CAD-D4-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 "Understand and Apply Mechanical Drawing Methods"

Introduction:

Technical lettering is an important skill that is often neglected. Of course, the use of CAD makes manual technical lettering much less prevalent. But, it is crucial that the students be aware of and have a basic skill for technical lettering.

Presentation Outline:

I. Discuss Lettering Style for Mechanical Drawings
  A. Gothic sans-serif (lit. Gothic without serifs)
  B. Standard height = 1/8 inch (3 mm)
  C. Use all capital letters
  D. Vertical or italic (inclined to right) letters
II. Lettering Technique
  A. Using straight-edge aids
    1. Using the T-square and triangle
    2. Using the Ames Lettering Guide
  B. Demonstrate proper construction techniques
    1. Follow prescribed guidelines for each letter
    2. Follow prescribed guidelines for each number
  C. Demonstrate proper spacing
    1. Spacing between letters
    2. Spacing between words
    3. Spacing between lines of text

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Use the technical lettering style to write the alphanumeric series, repeating each letter/number 2-5 times (use standard letter height and style);
b) Use the technical lettering style to write common drawing notes (general and local); and,
c) Answer review questions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D5) dealing with creating bill of materials/parts list.

CAD-D4-HO
Perform Technical Lettering
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand technical lettering styles;
b. Identify and apply technical lettering styles; and,
c. Identify and apply standard notations.

Module Outline:

I. Discuss Lettering Style for Mechanical Drawings
  A. Gothic sans-serif (lit. Gothic without serifs)
  B. Standard height = 1/8 inch (3 mm)
  C. Use all capital letters
  D. Vertical or italic (inclined to right) letters
II. Lettering Technique
  A. Using straight-edge aids
    1. Using the T-square and triangle
    2. Using the Ames Lettering Guide
  B. Demonstrate proper construction techniques
    1. Follow prescribed guidelines for each letter
    2. Follow prescribed guidelines for each number
  C. Demonstrate proper spacing
    1. Spacing between letters
    2. Spacing between words
    3. Spacing between lines of text

CAD-D4-LE

Perform Technical Lettering

Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Use the technical lettering style to write the alphanumeric series, repeating each letter/number 2-5 times (use standard letter height and style);

b) Use the technical lettering style to write common drawing notes (general and local); and,

c) Answer review questions.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D5

Subject: Computer-Aided Drafting & Design **Time: 3 Hrs.**

Duty: Prepare Mechanical Production Drawings
Task: Create Bill of Materials/Parts List

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify components included in bill of material/parts list;
b. Identify commercially available components in assembly;
c. Identify non-commercially available components in assembly; and,
d. Understand format of a bill of material/parts list.

Instructional Materials:

Textbook (see References for suitable texts)
CAD software
MASTER Handout (CAD-D5-HO)
MASTER Laboratory Exercise (CAD-D5-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 "Understand and Apply Mechanical Drawing Methods"
CAD-D2 "Create Detail Drawings"
CAD-D3 "Create Assembly Drawings"

Introduction:

Parts lists, or bills of material (BOM), are an important part of assembly drawings and working drawing sets. It represents the first step in the calculation of the machine cost, identifies which vendor must be used to get the purchased parts, and helps the assembler keep track of the total number of parts required for complete assembly.

Presentation Outline:

I. *Identify Need for Bill of Material (BOM)*
   A. *Discuss usage on assembly drawings*
   B. *Discuss correlation with detail drawings*
   C. *Discuss correlation with parts not represented by detail drawings (purchased parts)*

II. *Understand Format of a BOM*
   A. *Discuss location on drawing (including as a separate page)*
   B. *Discuss typical dimensions/sizes for BOM*
   C. *Discuss part description (part number, description, number required, etc.)*

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Use CAD to draw various styles of parts lists and add given parts data (see the recommended textbooks/references for various parts list styles); and,

b) Add a parts list to an assembly drawing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D6) dealing with applying dimensions and notes.

CAD-D8-HO
Create Bill of Materials/Parts List
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify components included in bill of material/parts list;
b. Identify commercially available components in assembly;
c. Identify non-commercially available components in assembly; and,
d. Understand format of a bill of material/parts list.

Module Outline:

I. Identify Need for Bill of Material (BOM)
    A. Discuss usage on assembly drawings
    B. Discuss correlation with detail drawings
    C. Discuss correlation with parts not represented by detail drawings (purchased parts)
II. Understand Format of a BOM
    A. Discuss location on drawing (including as a separate page)
    B. Discuss typical dimensions/sizes for BOM
    C. Discuss part description (part number, description, number required, etc.)

CAD-D8-LE
Create Bill of Materials/Parts List
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Use CAD to draw various styles of parts lists and add given parts data (see the recommended textbooks/references for various parts list styles); and,

b) Add a parts list to an assembly drawing.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D6

Subject: **Computer-Aided Drafting & Design** **Time: 14 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Apply Dimensions and Notes

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify dimensioning systems;
b. Understand and apply current dimensioning standards;
c. Understand dimensioning terminology; and,
d. Understand and apply dimensioning strategy.

Instructional Materials:

Textbook (see References for suitable texts)
CAD software
MASTER Handout (CAD-D6-HO)
MASTER Laboratory Exercise (CAD-D6-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-D1	"Understand and Apply Mechanical Drawing Methods"
CAD-D2	"Create Detail Drawings"
CAD-D3	"Create Assembly Drawings"
CAD-D4	"Perform Technical Lettering"
CAD-D5	"Create Bill of Materials/Parts List"

Introduction:

In technical mechanical drawing, proper dimensioning is arguably the most difficult skill for a beginner to acquire. It is also one of the most critical aspects of a mechanical drawing because it conveys so much information and fulfills so many functions. Dimensioning provides information for correct size determination, measurement indices for quality control, manufacturing information, and assembly information.

Presentation Outline:

I. Identify Dimensioning Systems
    A. Decimal-inch system
        1. Standard units: inches
        2. Proper number of decimal places
        3. Handling of leading and trailing zeros
    B. SI (metric) system
        1. Standard units: millimeters
        2. Proper number of decimal places
        3. Handling of leading and trailing zeros
II. Understand and Apply Current Dimensioning Standards
    A. Discuss ANSI Y14.5M dimensioning standards
    B. Discuss ISO dimensioning standards
III. Understand Dimensioning Terminology
    A. Discuss elements of a dimension
        1. Extension lines
        2. Dimension line
        3. Arrowheads
        4. Leaders
        5. Dimension text (number)
        6. General and local notes
        7. Center marks
IV. Understand and Apply Dimensioning Strategy
    A. Understand need for dimensions:
        1. Orthographic views of object provides accurate shape description
        2. Dimensioning needed to provide accurate size description
    B. Considerations while dimensioning:
        1. Consider finished object
        2. Consider production process(es) used to fabricate object
        3. Consider function of object
    C. Dimension in two steps:
        1. Dimension the SIZE of features
        2. Dimension the LOCATION of features with respect to each other

D. Apply dimensions according to the basic geometric shape of the features
    1. Show dimensions for rectangular prism
    2. Show dimensions for cylinder
    3. Show dimensions for hole ("negative" cylinder)
    4. Show dimensions for cone
    5. Show dimensions for pyramid
    6. Show dimensions for sphere (rarely used)
    7. Show dimensions for torus (rarely used)

E. Apply general guidelines while dimensioning:
    1. Dimensions should be convenient for assembly, fabrication, and inspection
    2. No scaling of dimensions
    3. No assumed dimensions
    4. No dimensions to inaccessible features
    5. No redundant or superfluous dimensions

F. Place dimensions properly according to logical and practical layout
    1. Locate center marks with dimensions
    2. Place dimensions on outside of object
    3. Apply *contour rule:* dimension in view where feature is shown in profile
    4. Establish and use datum surfaces
    5. Dimension the diameter of holes in their circular view
    6. Dimension the diameter of cylinders in their rectangular view
    7. Do not dimension to hidden lines/features
    8. Do not cross dimension lines
    9. Apply leaders radially
    10. Group notes above title block
    11. Use standard symbology for dimensions

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Dimension previously created orthographic drawings, starting with simple objects and progressing to more complex shapes;
b) Create orthographic representations of objects complete with dimensions; and,
c) Answer review questions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D7) dealing with performing dimensional limits and tolerances.

CAD-D6-HO
Apply Dimensions and Notes
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify dimensioning systems;
- b. Understand and apply current dimensioning standards;
- c. Understand dimensioning terminology; and,
- d. Understand and apply dimensioning strategy.

Module Outline:

- I. Identify Dimensioning Systems
  - A. Decimal-inch system
    - 1. Standard units: inches
    - 2. Proper number of decimal places
    - 3. Handling of leading and trailing zeros
  - B. SI (metric) system
    - 1. Standard units: millimeters
    - 2. Proper number of decimal places
    - 3. Handling of leading and trailing zeros
- II. Understand and Apply Current Dimensioning Standards
  - A. Discuss ANSI Y14.5M dimensioning standards
  - B. Discuss ISO dimensioning standards
- III. Understand Dimensioning Terminology
  - A. Discuss elements of a dimension
    - 1. Extension lines
    - 2. Dimension line
    - 3. Arrowheads
    - 4. Leaders
    - 5. Dimension text (number)
    - 6. General and local notes
    - 7. Center marks
- IV. Understand and Apply Dimensioning Strategy
  - A. Understand need for dimensions:
    - 1. Orthographic views of object provides accurate shape description
    - 2. Dimensioning needed to provide accurate size description
  - B. Considerations while dimensioning:
    - 1. Consider finished object
    - 2. Consider production process(es) used to fabricate object
    - 3. Consider function of object

C. Dimension in two steps:
  1. Dimension the SIZE of features
  2. Dimension the LOCATION of features with respect to each other

D. Apply dimensions according to the basic geometric shape of the features
  1. Show dimensions for rectangular prism
  2. Show dimensions for cylinder
  3. Show dimensions for hole ("negative" cylinder)
  4. Show dimensions for cone
  5. Show dimensions for pyramid
  6. Show dimensions for sphere (rarely used)
  7. Show dimensions for torus (rarely used)

E. Apply general guidelines while dimensioning:
  1. Dimensions should be convenient for assembly, fabrication, and inspection
  2. No scaling of dimensions
  3. No assumed dimensions
  4. No dimensions to inaccessible features
  5. No redundant or superfluous dimensions

F. Place dimensions properly according to logical and practical layout
  1. Locate center marks with dimensions
  2. Place dimensions on outside of object
  3. Apply *contour rule:* dimension in view where feature is shown in profile
  4. Establish and use datum surfaces
  5. Dimension the diameter of holes in their circular view
  6. Dimension the diameter of cylinders in their rectangular view
  7. Do not dimension to hidden lines/features
  8. Do not cross dimension lines
  9. Apply leaders radially
  10. Group notes above title block
  11. Use standard symbology for dimensions

CAD-D6-LE
Apply Dimensions and Notes
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Dimension previously created orthographic drawings, starting with simple objects and progressing to more complex shapes;

b) Create orthographic representations of objects complete with dimensions; and,

c) Answer review questions.

CAD-D7

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D7

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Apply Dimensional Limits and Tolerances

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand tolerancing practices;
b. Identify types of tolerances;
c. Apply tolerances to features;
d. Compute tolerance ranges;
e. Understand inch fit system;
f. Understand metric fit system;
g. Apply fit specifications to features;
h. Compute fits from tabular data and vice versa; and,
i. Identify types of fits.

Instructional Materials:

Fit tables (inch and metric)
(Use ANSI standards for current fit data)
MASTER Handout (CAD-D7-HO)
MASTER Laboratory Exercise (CAD-D7-LE)

References:

The following are recommended as reference material.

1. ANSI B4.2, *Preferred Metric Limits and Fits*
2. ANSI B4.1, *Preferred Limits and Fits for Cylindrical Parts*
3. ANSI Y14.5M, *Dimensioning and Tolerancing*

Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 "Understand and Apply Mechanical Drawing Methods"
CAD-D2 "Create Detail Drawings:
CAD-D4 "Perform Technical Lettering"

CAD-D6 "Apply Dimensions and Notes"

Introduction:

The most accurate machining operation in the world will never produce mechanical parts exactly as dimensioned on the drawing. For this reason it is necessary to provide upper and lower limits for dimensions which control the size and location of important part features. Without these limits on the dimensions it would be virtually impossible to perform today's high-volume/low-cost manufacturing with any consistency: assembly would be haphazardous, replacement parts would be astronomically priced and wasted parts would abound.

Presentation Outline:

I. Discuss the Need and Purpose for Dimensional Limits
  A. History of engineering dimensioning and manufacturing
    1. Before mass production (Henry Ford's assembly line) each part was manufactured as a unique entity
    2. Mass production required that all parts in a machine must be manufactured and assembled accurately and quickly, with little variation between batches
  B. Inherent inaccuracy in manufacturing operations
    1. Measuring with 100% accuracy is impossible
    2. Cutting, grinding, forming, etc., with 100% accuracy is impossible
  C. Mass production techniques
    1. Identical parts manufactured on the same machine will have dimensional variations
    2. Knowledge of permissible/allowable size variations will allow for better product control
  D. Part interchangeability
II. Limits and Tolerances
  A. Define ***limits*** - permissible variations in the specified form, size, or location of individual features of a part from that shown on the drawing
  B. Define ***tolerances*** - largest and smallest permissible sizes
  C. Define other key concepts:
    1. Actual size
    2. Basic size
    3. Design size
    4. Limits of size
    5. Nominal size
    6. Maximum material condition
  D. Discuss tolerance type and format

      1. Bilateral tolerance
      2. Unilateral tolerance
      3. Equal and unequal tolerances
   E. Discuss tolerance dimensions
      1. Limit dimensions
         a. When are limit dimensions used and why
         b. Show limit dimensions applied to circular features and rectangular features
      2. Plus/minus (±) tolerancing dimensions
         a. When are plus/minus tolerance dimensions used and why
         b. Show plus/minus tolerance dimensions applied to circular features and rectangular features
      3. General tolerance notes
      4. Dimensional units
         a. Metric tolerances
         b. Inch tolerances
      5. Tolerance accumulation
         a. Continuous (chain) dimensions
         b. Baseline (datum) dimensions
         c. Direct dimensions

III. Fits and Allowances
   A. Define *fit* - relationship between two mating parts with respect to the amount of clearance or interference present when they are assembled
   B. Discuss types of fits
      1. Clearance fits
      2. Interference fits
      3. Transitions fits
   C. Define other key concepts:
      1. Basic size
      2. Deviation
         a. Upper deviation
         b. Lower deviation
      3. Tolerance zone
      4. Fundamental deviation
   D. Discuss standard inch fits
      1. Discuss which fits correspond to specific manufacturing operations
      2. Discuss which fits correspond to specific assembly operations
      3. Types of inch fits:
         a. Running and sliding fits (RC1 to RC9)
         b. Locational clearance fits (LC1 to LC11)
         c. Locational transition fits (LT1 to LT6)
         d. Locational interference fits (LN1 to LN6)
         e. Force or shrink fits (FN1 to FN5)

    4. Discuss basic hole system
        a. Demonstrate how to find fit values in appropriate tables
        b. Show calculations to determine proper fit specifications
    5. Discuss basic shaft system
        a. Demonstrate how to find fit values in appropriate tables
        b. Show calculations to determine proper fit specifications
    6. Show proper format for dimensioning inch fits
E. Discuss standard metric fits
    1. Discuss which fits correspond to specific manufacturing operations
    2. Discuss which fits correspond to specific assembly operations
    3. Discuss metric tolerance grades
        a. Discuss application of tolerance grades to various manufacturing operations
        b. Discuss metric fit codes based on tolerance grades
    4. Discuss basic hole system
        a. Demonstrate how to find fit values in appropriate tables
        b. Show calculations to determine proper fit specifications
    5. Discuss basic shaft system
        a. Demonstrate how to find fit values in appropriate tables
        b. Show calculations to determine proper fit specifications
    6. Show proper format for dimensioning metric fits

Practical Application:

Students will be given homework assignments in which they must:
a) Compute limit dimensions and tolerances given fit specifications; and,
b) Determine fit specifications given application and dimensional information.

Students will be given drawing assignments in which they must perform the above computations and:
a) Make the appropriate detail drawings of the specified part with limit dimensions and fits specifications; and,
b) Create drawings of assembled parts with proper fits between mating parts.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D8) dealing with applying current drafting standards during the generation of mechanical drawings. This module will cumulatively apply **MASTER Technical Modules CAD-D1** through **CAD-D7**.

CAD-D7-HO
Apply Dimensional Limits and Tolerances
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand tolerancing practices;
- b. Identify types of tolerances;
- c. Apply tolerances to features;
- d. Compute tolerance ranges;
- e. Understand inch fit system;
- f. Understand metric fit system;
- g. Apply fit specifications to features;
- h. Compute fits from tabular data and vice versa; and,
- i. Identify types of fits.

Module Outline:

- I. Discuss the Need and Purpose for Dimensional Limits
  - A. History of engineering dimensioning and manufacturing
    - 1. Before mass production (Henry Ford's assembly line) each part was manufactured as a unique entity
    - 2. Mass production required that all parts in a machine must be manufactured and assembled accurately and quickly, with little variation between batches
  - B. Inherent inaccuracy in manufacturing operations
    - 1. Measuring with 100% accuracy is impossible
    - 2. Cutting, grinding, forming, etc., with 100% accuracy is impossible
  - C. Mass production techniques
    - 1. Identical parts manufactured on the same machine will have dimensional variations
    - 2. Knowledge of permissible/allowable size variations will allow for better product control
  - D. Part interchangeability
- II. Limits and Tolerances
  - A. Define *limits* - permissible variations in the specified form, size, or location of individual features of a part from that shown on the drawing
  - B. Define *tolerances* - largest and smallest permissible sizes
  - C. Define other key concepts:
    - 1. Actual size
    - 2. Basic size

        - 3. Design size
        - 4. Limits of size
        - 5. Nominal size
        - 6. Maximum material condition
    - D. Discuss tolerance type and format
        - 1. Bilateral tolerance
        - 2. Unilateral tolerance
        - 3. Equal and unequal tolerances
    - E. Discuss tolerance dimensions
        - 1. Limit dimensions
            - a. When are limit dimensions used and why
            - b. Show limit dimensions applied to circular features and rectangular features
        - 2. Plus/minus (±) tolerancing dimensions
            - a. When are plus/minus tolerance dimensions used and why
            - b. Show plus/minus tolerance dimensions applied to circular features and rectangular features
        - 3. General tolerance notes
        - 4. Dimensional units
            - a. Metric tolerances
            - b. Inch tolerances
        - 5. Tolerance accumulation
            - a. Continuous (chain) dimensions
            - b. Baseline (datum) dimensions
            - c. Direct dimensions
- III. Fits and Allowances
    - A. Define *fit* - relationship between two mating parts with respect to the amount of clearance or interference present when they are assembled
    - B. Discuss types of fits
        - 1. Clearance fits
        - 2. Interference fits
        - 3. Transitions fits
    - C. Define other key concepts:
        - 1. Basic size
        - 2. Deviation
            - a. Upper deviation
            - b. Lower deviation
        - 3. Tolerance zone
        - 4. Fundamental deviation
    - D. Discuss standard inch fits
        - 1. Discuss which fits correspond to specific manufacturing operations
        - 2. Discuss which fits correspond to specific assembly operations
        - 3. Types of inch fits:

a. Running and sliding fits (RC1 to RC9)
b. Locational clearance fits (LC1 to LC11)
c. Locational transition fits (LT1 to LT6)
d. Locational interference fits (LN1 to LN6)
e. Force or shrink fits (FN1 to FN5)

4. Discuss basic hole system
   a. Demonstrate how to find fit values in appropriate tables
   b. Show calculations to determine proper fit specifications
5. Discuss basic shaft system
   a. Demonstrate how to find fit values in appropriate tables
   b. Show calculations to determine proper fit specifications
6. Show proper format for dimensioning inch fits

E. Discuss standard metric fits

1. Discuss which fits correspond to specific manufacturing operations
2. Discuss which fits correspond to specific assembly operations
3. Discuss metric tolerance grades
   a. Discuss application of tolerance grades to various manufacturing operations
   b. Discuss metric fit codes based on tolerance grades
4. Discuss basic hole system
   a. Demonstrate how to find fit values in appropriate tables
   b. Show calculations to determine proper fit specifications
5. Discuss basic shaft system
   a. Demonstrate how to find fit values in appropriate tables
   b. Show calculations to determine proper fit specifications
6. Show proper format for dimensioning metric fits

CAD-D7-LE
Apply Dimensional Limits and Tolerances
Attachment 2: MASTER Laboratory Exercise

Students will be given homework assignments in which they must:

a) Compute limit dimensions and tolerances given fit specifications; and,

b) Determine fit specifications given application and dimensional information.

Students will be given drawing assignments in which they must perform the above computations and:

a) Make the appropriate detail drawings of the specified part with limit dimensions and fits specifications; and,

b) Create drawings of assembled parts with proper fits between mating parts.

CAD-D8

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D8

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Apply Current Drafting Standards to Drawings

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand relevant standards;
b. Identify sources of standards;
c. Reference standards; and,
d. Apply relevant standards.

Instructional Materials:

Textbook (see References for suitable texts)
Various standards reference sources (ANSI, ISO)
MASTER Handout (CAD-D8-HO)
MASTER Laboratory Exercise (CAD-D8-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition
Standards reference sources (ANSI, ISO)

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-D1	"Understand and Apply Mechanical Drawing Methods"
CAD-D2	"Create Detail Drawings"
CAD-D3	"Create Assembly Drawings"
CAD-D4	"Perform Technical Lettering"
CAD-D5	"Create Bill of Materials/Parts List"
CAD-D6	"Apply Dimensions and Notes"
CAD-D7	"Apply Dimensional Limits and Tolerances"

Introduction:

Industrial standards are a crucial element in mechanical design and drafting. They create a universal language which allows efficient and effective communication between all areas of design and manufacturing. Standards also make transfer of engineering information between companies possible, even between companies on different continents without a common language.

Presentation Outline:

I. Purpose of Standards
    A. Create universal language
    B. Provide rules and guidelines
    C. Detail methods and procedures
II. Types of Standards
    A. Industry
        1. ANSI – American National Standards Institute
            a. Uses English system of units (basic linear unit = inch)
            b. Used by most companies dealing with mechanical design and drafting in the United States
            c. Many standards developed in conjunction with the American Society of Mechanical Engineers (ASME) and the Society of Automotive Engineers (SAE)
        2. ISO – International Standards Organization
            a. Uses SI (metric) system of units (basic linear unit = millimeter)
            b. Used by most companies dealing with mechanical design and drafting throughout Europe and Asia
    B. Company
        1. Specific to the company and/or department
        2. Usually a modification of the ANSI or ISO standards
        3. Acts to establish and maintain a consistency within the company
III. ANSI Standards Relevant to Mechanical Design and Drafting
    A. ANSI produces hundreds of standards relevant to mechanical design and drafting
    B. Short list of relevant areas of standardization
        1. Drafting
        2. Dimensioning and Surface Finish
        3. Graphic Symbols
        4. Bolts, Screws, and Nuts
        5. Gears
        6. Keys and Pins
        7. Piping

    8. Rivets
    9. Threads
    10. Washers
- C. Main Standards
    1. Dimensioning and Tolerancing, ANSI/ASME Y14.5M-1994
    2. Multiview and Sectional View Drawings, ANSI/ASME Y14.3M-1994
    3. Engineering Drawings, Types, and Applications, ANSI/ASME Y14.24M-1989
    4. Mechanical Assemblies, ANSI/ASME Y14.14
- D. Other Often Used ANSI Standards
    1. Preferred Limits and Fits for Cylindrical Parts, ANSI B4.1-1967 (R1994)
    2. General Tolerances for Metric Dimensioned Products, ANSI B4.3-1978 (R1994)
    3. Preferred Metric Limits and Fits, ANSI B4.2-1978 (R1994)
    4. Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
    5. Gear and Spline Drawing Standards – Part 1, for Spur, Helical, Double Helical, and Rack, ANSI/ASME Y14.7.1-1971 (R1993)
    6. Gear and Spline Drawing Standards – Part 2, Bevel and Hypoid Gears, ANSI/ASME Y14.7.2-1978 (R1994)
    7. Parts Lists, Data Lists, and Index Lists, ANSI/ASME Y14.34M-1990
    8. Screw Thread Representation, ANSI/ASME Y14.6-1978 (R1993)
    9. Screw Thread Representation, Metric, ANSI/ASME Y14.6aM-1981 (R1993)

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Identify standards organizations;
b) Discuss the purpose of standards in the mechanical design and drafting field; and,
c) Identify which standards would be appropriate for specific drafting assignments.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D9) dealing with performing drawing revisions.

CAD-D8-HO
Apply Current Drafting Standards to Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand relevant standards;
b. Identify sources of standards;
c. Reference standards; and,
d. Apply relevant standards.

Module Outline:

I. Purpose of Standards
   A. Create universal language
   B. Provide rules and guidelines
   C. Detail methods and procedures
II. Types of Standards
   A. Industry
      1. ANSI – American National Standards Institute
         a. Uses English system of units (basic linear unit = inch)
         b. Used by most companies dealing with mechanical design and drafting in the United States
         c. Many standards developed in conjunction with the American Society of Mechanical Engineers (ASME) and the Society of Automotive Engineers (SAE)
      2. ISO – International Standards Organization
         a. Uses SI (metric) system of units (basic linear unit = millimeter)
         b. Used by most companies dealing with mechanical design and drafting throughout Europe and Asia
   B. Company
      1. Specific to the company and/or department
      2. Usually a modification of the ANSI or ISO standards
      3. Acts to establish and maintain a consistency within the company
III. ANSI Standards Relevant to Mechanical Design and Drafting
   A. ANSI produces hundreds of standards relevant to mechanical design and drafting
   B. Short list of relevant areas of standardization
      1. Drafting
      2. Dimensioning and Surface Finish
      3. Graphic Symbols

   4. Bolts, Screws, and Nuts
   5. Gears
   6. Keys and Pins
   7. Piping
   8. Rivets
   9. Threads
   10. Washers

C. Main Standards
   1. Dimensioning and Tolerancing, ANSI/ASME Y14.5M-1994
   2. Multiview and Sectional View Drawings, ANSI/ASME Y14.3M-1994
   3. Engineering Drawings, Types, and Applications, ANSI/ASME Y14.24M-1989
   4. Mechanical Assemblies, ANSI/ASME Y14.14

D. Other Often Used ANSI Standards
   1. Preferred Limits and Fits for Cylindrical Parts, ANSI B4.1-1967 (R1994)
   2. General Tolerances for Metric Dimensioned Products, ANSI B4.3-1978 (R1994)
   3. Preferred Metric Limits and Fits, ANSI B4.2-1978 (R1994)
   4. Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
   5. Gear and Spline Drawing Standards – Part 1, for Spur, Helical, Double Helical, and Rack, ANSI/ASME Y14.7.1-1971 (R1993)
   6. Gear and Spline Drawing Standards – Part 2, Bevel and Hypoid Gears, ANSI/ASME Y14.7.2-1978 (R1994)
   7. Parts Lists, Data Lists, and Index Lists, ANSI/ASME Y14.34M-1990
   8. Screw Thread Representation, ANSI/ASME Y14.6-1978 (R1993)
   9. Screw Thread Representation, Metric, ANSI/ASME Y14.6aM-1981 (R1993)

CAD-D8-LE
Apply Current Drafting Standards to Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Identify standards organizations;

b) Discuss the purpose of standards in the mechanical design and drafting field; and,

c) Identify which standards would be appropriate for specific drafting assignments.

CAD-D9

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D9

Subject: **Computer-Aided Drafting & Design** **Time: 4 Hrs.**

Duty: **Prepare Mechanical Production Drawings**
Task: Perform Drawing Revisions

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand reason for revision;
b. Apply revision notation; and,
c. Complete revision documentation.

Instructional Materials:

Textbook
MASTER Handout (CAD-D9-HO)
MASTER Laboratory Exercise (CAD-D9-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-D1	"Understand and Apply Mechanical Drawing Methods"
CAD-D2	"Create Detail Drawings"
CAD-D3	"Create Assembly Drawings"
CAD-D4	"Perform Technical Lettering"
CAD-D5	"Create Bill of Materials/Parts List"
CAD-D6	"Apply Dimensions and Notes"
CAD-D7	"Apply Dimensional Limits and Tolerances"
CAD-D8	"Apply Current Drafting Standards to Drawings"

Introduction:

Changes in a drawings are necessitated by many factors. Regardless of the cause, revisions to a drawing must be handled in a efficient, simple, and standardized manner.

Presentation Outline:

I. Purpose of Revisions
  A. Define revision: a change or modification made to a design which is reflected in the engineering drawings
  B. Standard: Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
  C. Common types of revisions
    1. Changes in design
    2. Changes in material
    3. Changes in manufacturing processes/tooling
    4. Fixing errors in drawing
    5. Changes in dimensions
    6. Change in customer requirements
II. Procedure
  A. Change made directly to drawing
  B. Remove original item, replace with change or modification
  C. A balloon and number are placed adjacent to revision
  D. Description of revision is made in the revision block
III. Revision Block
  A. Block size similar to title block or parts list
  B. Areas for revision number, revision explanation, date, and signature of checker
    1. Revision number corresponds to balloon number
    2. Description should include information from original item (before revision)
    3. Zone numbers may be used in place of balloon numbers
  C. Allowance made for future revisions

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Describe the process of making revisions, including definition and required components; and,

b) Make revisions to an existing drawing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-D10) dealing with using commercial and vendor data.

CAD-D9-HO
Perform Drawing Revisions
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand reason for revision;
- b. Apply revision notation; and,
- c. Complete revision documentation.

Module Outline:

- I. Purpose of Revisions
  - A. Define revision: a change or modification made to a design which is reflected in the engineering drawings
  - B. Standard: Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
  - C. Common types of revisions
    - 1. Changes in design
    - 2. Changes in material
    - 3. Changes in manufacturing processes/tooling
    - 4. Fixing errors in drawing
    - 5. Changes in dimensions
    - 6. Change in customer requirements
- II. Procedure
  - A. Change made directly to drawing
  - B. Remove original item, replace with change or modification
  - C. A balloon and number are placed adjacent to revision
  - D. Description of revision is made in the revision block
- III. Revision Block
  - A. Block size similar to title block or parts list
  - B. Areas for revision number, revision explanation, date, and signature of checker
    - 1. Revision number corresponds to balloon number
    - 2. Description should include information from original item (before revision)
    - 3. Zone numbers may be used in place of balloon numbers
  - C. Allowance made for future revisions

CAD-D9-LE
Perform Drawing Revisions
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Describe the process of making revisions, including definition and required components; and,

b) Make revisions to an existing drawing.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-D10

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Prepare Mechanical Production Drawings**
Task: Use Commercial and Vendor Data

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand commercial supplier catalogs; and,
b. Understand vendor drawings.

Instructional Materials:

Textbook
Various commercial supplier catalogs
MASTER Handout (CAD-D10-HO)
MASTER Laboratory Exercise (CAD-D10-LE)

References:

Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 "Understand and Apply Mechanical Drawing Methods"

Introduction:

In practically every machine or mechanism there are parts which are purchased from outside (vendor) sources. These parts may include such common items as bolts, screws, gears, and bearings. In order to use these items in a design, and draw the items correctly, the mechanical designer must reference vendor catalogs for the necessary design data. This may include dimensions, weight, material type, application data.

Presentation Outline:

I. Describe Vendor Catalogs: Catalogs of Purchased Parts Typically Used in the Design of Mechanical Parts
II. Discuss Standard Parts Which Are Purchased Using Vendor Catalogs
  A. Fasteners
    1. Threaded (English and metric) (including washers and nuts)
    2. Non-threaded (retaining rings, pins, etc.)
  B. Bearings and bushings
  C. Gears
  D. Belt drives
  E. Chain drives
  F. Miscellaneous parts
    1. Couplings
    2. Cams
III. Discuss Types of Catalogs
  A. Catalogs from the manufacturer of the specific part (e.g., Waldes Tru-Arc Snap Rings, Boston Gear Works, American Drill Bushing Co., SKF Bearings)
  B. Catalogs from a supply shop carrying many different types of mechanical parts (e.g., McMaster-Carr, W.W. Grainger)
IV. Discuss How to Use Catalogs
  A. Must have specification data such as shaft size, housing diameter, material thickness, material type, conditions of usage, load, speed, etc.
  B. Specifications vary according to the type of part desired and its use
  C. Parts used in conjunction with shafts are typically specified by the shaft diameter

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This is the last technical module under Duty D: Prepare Mechanical Production Drawings. The next duty is E: Assist Engineering Personnel, and the first **MASTER Technical Module is CAD-E1:** Understand Basic Design Procedures.

CAD-D10-HO
Use Commercial and Vendor Data
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand commercial supplier catalogs; and,
- b. Understand vendor drawings.

Module Outline:

- I. Describe Vendor Catalogs: Catalogs of Purchased Parts Typically Used in the Design of Mechanical Parts
- II. Discuss Standard Parts Which Are Purchased Using Vendor Catalogs
  - A. Fasteners
    - 1. Threaded (English and metric) (including washers and nuts)
    - 2. Non-threaded (retaining rings, pins, etc.)
  - B. Bearings and bushings
  - C. Gears
  - D. Belt drives
  - E. Chain drives
  - F. Miscellaneous parts
    - 1. Couplings
    - 2. Cams
- III. Discuss Types of Catalogs
  - A. Catalogs from the manufacturer of the specific part (e.g., Waldes Tru-Arc Snap Rings, Boston Gear Works, American Drill Bushing Co., SKF Bearings)
  - B. Catalogs from a supply shop carrying many different types of mechanical parts (e.g., McMaster-Carr, W.W. Grainger)
- IV. Discuss How to Use Catalogs
  - A. Must have specification data such as shaft size, housing diameter, material thickness, material type, conditions of usage, load, speed, etc.
  - B. Specifications vary according to the type of part desired and its use
  - C. Parts used in conjunction with shafts are typically specified by the shaft diameter

CAD-D10-LE
Use Commercial and Vendor Data
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E1

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Assist Engineering Personnel**
Task: Understand Basic Design Procedures

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify design process; and,
b. Discuss application of design methods.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E1-HO)
MASTER Laboratory Exercise (CAD-E1-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-D1 through CAD-D10 "Prepare Mechanical Production Drawings"

Introduction:

Machine design is where art meets science. Machine design is often more art than science, but all great designers draw on every engineering discipline to create an effective, practical, and efficient machine or mechanism.

Process is very important as it acts to organize the mind and channel energy into specific areas so that essential factors in the design are not overlooked.

Presentation Outline:

- I. Define Machine Design: Application of Science and Technology to Devise New or Improved Products for the Purpose of Satisfying Human Needs
  - A. Discuss types of needs
    - 1. Well-defined needs
    - 2. Vague needs
- II. Discuss Phases of Design
  - A. List and discuss the phases of the design process
    - 1. Recognition of Need
      - a. Creative phase
      - b. Triggered by various circumstances
      - c. Distinctly different from "Definition of Problem"
    - 2. Definition of Problem
      - a. Must include all specifications for machine or mechanism
      - b. Specifications include cost range, weight range, life range, reliability, characteristics, dimensions, limitations, operating conditions, etc.
    - 3. Synthesis
      - a. Optimum solution is synthesized
      - b. Iterative process involving "Analysis and Optimization" phase
    - 4. Analysis and Optimization
      - a. Design is tested
      - b. Testing is done through mathematical modeling
    - 5. Evaluation
      - a. Prototype is tested under real-world conditions
      - b. The next phase of testing after "Analysis and Optimization"
      - c. Some factors to consider during testing:
        - (1) Strength
        - (2) Reliability
        - (3) Thermal considerations
        - (4) Corrosion
        - (5) Wear
        - (6) Friction
        - (7) Cost
        - (8) Safety
        - (9) Weight
        - (10) Noise
        - (11) Control
        - (12) Stiffness
        - (13) Lubrication
        - (14) Maintenance

        6. Presentation of Results
    - B. Discuss the order of phases in the design process
    - C. Discuss feedback loops and iterative steps and how they are essential to the design process
    - D. Discuss other examples of the design process

III. Discuss Design Methods
    - A. Discuss principles of Design For Manufacturing (DFM)
    - B. Discuss principles of Reverse Engineering
    - C. Discuss principles of Design For Assembly (DFA)

IV. Discuss Knowledge Relevant to Machine Design
    - A. Mechanical drawing
    - B. Kinematics
    - C. Mechanics
    - D. Materials engineering
    - E. Strength of materials
    - F. Manufacturing processes
    - G. Thermodynamics
    - H. Fluid dynamics

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E2) dealing with utilizing fasteners for mechanical applications.

CAD-E1-HO
Understand Basic Design Procedures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify design process; and,
b. Discuss application of design methods.

Module Outline:

- I. Define Machine Design: Application of Science and Technology to Devise New or Improved Products for the Purpose of Satisfying Human Needs
  - A. Discuss types of needs
    - 1. Well-defined needs
    - 2. Vague needs
- II. Discuss Phases of Design
  - A. List and discuss the phases of the design process
    - 1. Recognition of Need
      - a. Creative phase
      - b. Triggered by various circumstances
      - c. Distinctly different from "Definition of Problem"
    - 2. Definition of Problem
      - a. Must include all specifications for machine or mechanism
      - b. Specifications include cost range, weight range, life range, reliability, characteristics, dimensions, limitations, operating conditions, etc.
    - 3. Synthesis
      - a. Optimum solution is synthesized
      - b. Iterative process involving "Analysis and Optimization" phase
    - 4. Analysis and Optimization
      - a. Design is tested
      - b. Testing is done through mathematical modeling
    - 5. Evaluation
      - a. Prototype is tested under real-world conditions
      - b. The next phase of testing after "Analysis and Optimization"
      - c. Some factors to consider during testing:
        - (1) Strength
        - (2) Reliability
        - (3) Thermal considerations
        - (4) Corrosion

        - (5) Wear
        - (6) Friction
        - (7) Cost
        - (8) Safety
        - (9) Weight
        - (10) Noise
        - (11) Control
        - (12) Stiffness
        - (13) Lubrication
        - (14) Maintenance
    - 6. Presentation of Results
  - B. Discuss the order of phases in the design process
  - C. Discuss feedback loops and iterative steps and how they are essential to the design process
  - D. Discuss other examples of the design process
- III. Discuss Design Methods
  - A. Discuss principles of Design For Manufacturing (DFM)
  - B. Discuss principles of Reverse Engineering
  - C. Discuss principles of Design For Assembly (DFA)
- IV. Discuss Knowledge Relevant to Machine Design
  - A. Mechanical drawing
  - B. Kinematics
  - C. Mechanics
  - D. Materials engineering
  - E. Strength of materials
  - F. Manufacturing processes
  - G. Thermodynamics
  - H. Fluid dynamics

CAD-E1-HO
Understand Basic Design Procedures
Attachment 1: MASTER Handout

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.

CAD-E2

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E2

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Utilize Fasteners for Mechanical Applications

Objective(s):

Upon completion of this unit the student will be able to:

a. Select appropriate fasteners and springs for application;
b. Understand basic fasteners and spring analysis;
c. Identify types of fasteners and springs; and,
d. Use supplier catalogs and standard references to select fasteners and springs for mechanical application.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E2-HO)
MASTER Laboratory Exercise (CAD-E2-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-E1 "Understand Basic Design Procedures"

Introduction:

Fasteners are the commonly used mechanical device. Students must be comfortable with every aspect of their use: from their selection, to their drawing, and finally their required computations.

Presentation Outline:

- I. Discuss Threaded Fasteners
  - A. Discuss features of threaded fasteners
    - 1. Discuss thread form
    - 2. Discuss thread terminology
  - B. Discuss fastener types: bolts, screws, nuts, set screws
  - C. Discuss graphical representation of threads
    - 1. Demonstrate detailed representation
    - 2. Demonstrate schematic representation
    - 3. Demonstrate simplified representation
  - D. Demonstrate the procedure for representing internal threads (tapped holes)
  - E. Demonstrate the procedure for representing external threads (screws, bolts, etc.)
  - F. Discuss thread symbology for dimensioning
  - G. Discuss use of threaded fasteners
    - 1. Demonstrate assembly techniques with fasteners
    - 2. Compute load analysis for fasteners
      - a. Compute force loading
      - b. Determine bolt patterns
- II. Discuss Non-Threaded Fasteners
  - A. Discuss common types of non-threaded fasteners:
    - 1. Retaining rings (also known as "snap rings"): prevent relative axial motion between a shaft and a hub
      - a. Internal retaining rings: ring fits into a groove cut into the surface of a hole in a hub
      - b. External retaining rings: ring fits into a groove cut into the surface of a shaft
      - c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
      - d. Discuss method of representation on drawings
        - (1) Notations
        - (2) Dimensions
        - (3) Graphical representation – shaft, hole, and retaining ring
    - 2. Keys: prevent relative rotational motion between a shaft and a hub
      - a. Discuss types of keys: square, flat, Gib-head, Pratt & Whitney, Woodruff
      - b. Discuss necessary features for using keys – keyway in hub, keyseat in shaft (shaped for each type of key)
      - c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.

        - d. Compute loading on key, shaft, and hub
        - e. Discuss method of representation on drawings
            - (1) Notation
            - (2) Dimensions
            - (3) Graphical representation – keyseat, keyway, key
    - 3. Pins: prevent relative axial and rotation motion between a shaft and a hub
        - a. Discuss types of pins – semi-permanent, quick-release
            - (1) Machine pins: dowel pins, taper pins, clevis pins, cotter pins
            - (2) Radial locking pins
            - (3) Grooved straight pins
            - (4) Spring pins
            - (5) Quick-release pins: push-pull pins, positive locking pins
        - b. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
        - c. Compute loading on pin, shaft, hub
        - d. Discuss method of representation on drawings
            - (1) Notation
            - (2) Dimensions
            - (3) Graphical representation
    - 4. Discuss briefly other types of non-threaded fasteners: rivets, splines/serrations, knurled joints, adhesives, clips, etc.
- B. Discuss springs
    - 1. Discuss types of springs: compression, extension, flat, and torsion springs
    - 2. Discuss application of springs
    - 3. Discuss method of selection from supplier catalogs
    - 4. Discuss methods of representation on drawings
        - a) Notation
        - b) Dimensions
        - c) Graphical representation
    - 5. Compute design parameters: deflection, stress, loading, etc.

Practical Application:

Students will be given classwork and homework assignments in which they must:

- a) Answer review questions; and,
- b) Given design application with loading parameters, select specified fastener. Students should complete 3-5 problems for each type of fastener listed above.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E3) dealing with utilizing power transmission elements for mechanical applications.

CAD-E2-HO
Utilize Fasteners for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Select appropriate fasteners and springs for application;
b. Understand basic fasteners and spring analysis;
c. Identify types of fasteners and springs; and,
d. Use supplier catalogs and standard references to select fasteners and springs for mechanical application.

Module Outline:

I. Discuss Threaded Fasteners
   A. Discuss features of threaded fasteners
      1. Discuss thread form
      2. Discuss thread terminology
   B. Discuss fastener types: bolts, screws, nuts, set screws
   C. Discuss graphical representation of threads
      1. Demonstrate detailed representation
      2. Demonstrate schematic representation
      3. Demonstrate simplified representation
   D. Demonstrate the procedure for representing internal threads (tapped holes)
   E. Demonstrate the procedure for representing external threads (screws, bolts, etc.)
   F. Discuss thread symbology for dimensioning
   G. Discuss use of threaded fasteners
      1. Demonstrate assembly techniques with fasteners
      2. Compute load analysis for fasteners
         a. Compute force loading
         b. Determine bolt patterns

II. Discuss Non-Threaded Fasteners
   A. Discuss common types of non-threaded fasteners:
      1. Retaining rings (also known as “snap rings”): prevent relative axial motion between a shaft and a hub
         a. Internal retaining rings: ring fits into a groove cut into the surface of a hole in a hub
         b. External retaining rings: ring fits into a groove cut into the surface of a shaft
         c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.

- d. Discuss method of representation on drawings
  - (1) Notations
  - (2) Dimensions
  - (3) Graphical representation – shaft, hole, and retaining ring

2. Keys: prevent relative rotational motion between a shaft and a hub
   - a. Discuss types of keys: square, flat, Gib-head, Pratt & Whitney, Woodruff
   - b. Discuss necessary features for using keys – keyway in hub, keyseat in shaft (shaped for each type of key)
   - c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
   - d. Compute loading on key, shaft, and hub
   - e. Discuss method of representation on drawings
     - (1) Notation
     - (2) Dimensions
     - (3) Graphical representation – keyseat, keyway, key
3. Pins: prevent relative axial and rotation motion between a shaft and a hub
   - a. Discuss types of pins – semi-permanent, quick-release
     - (1) Machine pins: dowel pins, taper pins, clevis pins, cotter pins
     - (2) Radial locking pins
     - (3) Grooved straight pins
     - (4) Spring pins
     - (5) Quick-release pins: push-pull pins, positive locking pins
   - b. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
   - c. Compute loading on pin, shaft, hub
   - d. Discuss method of representation on drawings
     - (1) Notation
     - (2) Dimensions
     - (3) Graphical representation
4. Discuss briefly other types of non-threaded fasteners: rivets, splines/serrations, knurled joints, adhesives, clips, etc.

B. Discuss springs

1. Discuss types of springs: compression, extension, flat, and torsion springs
2. Discuss application of springs
3. Discuss method of selection from supplier catalogs
4. Discuss methods of representation on drawings
   - a) Notation
   - b) Dimensions

    c) Graphical representation

5. Compute design parameters: deflection, stress, loading, etc.

CAD-E2-LE
Utilize Fasteners for Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) **Answer review questions; and,**

b) **Given design application with loading parameters, select specified fastener. Students should complete 3-5 problems for each type of fastener listed above.**

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E3

Subject: **Computer-Aided Drafting & Design** **Time: 15 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Utilize Power Transmission Elements for Mechanical Applications

Objective(s)

Upon completion of this unit the student will be able to:

a. Select appropriate power transmission elements for application;
b. Understand basic power transmission element analysis;
c. Identify types of power transmission elements; and,
d. Use supplier catalogs and standard references to select power transmission elements for mechanical applications.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E3-HO)
MASTER Laboratory Exercise (CAD-E3-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-E1 "Understand Basic Design Procedures"
CAD-E2 "Utilize Fasteners for Mechanical Applications"

Introduction:

In some form or fashion, nearly every machine will transmit power from an input source to an output. This is most commonly done through transmission shafting. The

requirements to accommodate this power transmission in the design of the machine are numerous and critical to the proper function of the machine.

In the design of machinery, engineers make all the critical calculations for the determination of the best method for transmitting power. Once the necessary system has been selected, it is the job of the mechanical design technician to select the proper components and perform the remaining computations to determine proper fit and usability.

Presentation Outline:

- I. Define "Power Transmission Element": Machine Element Used in the Transmission of Power from One Location to Another
- II. Discuss Gear Drives
  - A. Discuss gear terminology
  - B. Discuss spur gears
    - 1. Discuss method of representation on drawings
      - a. Notation
      - b. Dimensions
      - c. Graphical representation
        - (1) Detail drawings
        - (2) Assembly drawings
    - 2. Design spur gear drive systems
      - a. Compute power-transmitting capacity
      - b. Select drive components from supplier catalogs
      - c. Determine assembly methods for drive system components
  - C. Discuss rack and pinion gears
    - 1. Discuss method of representation on drawings
      - a. Notation
      - b. Dimensions
      - c. Graphical representation
        - (1) Detail drawings
        - (2) Assembly drawings
    - 2. Design rack and pinion gear drive systems
      - a. Compute power-transmitting capacity
      - b. Select drive components from supplier catalogs
      - c. Determine assembly methods for drive system components
  - D. Discuss bevel gears
    - 1. Discuss method of representation on drawings
      - a. Notation
      - b. Dimensions
      - c. Graphical representation

            - (1) Detail drawings
            - (2) Assembly drawings
    - 2. Design bevel gear drive systems
        - a. Compute power-transmitting capacity
        - b. Select drive components from supplier catalogs
        - c. Determine assembly methods for drive system components
- E. Discuss worm and worm gears
    - 1. Discuss method of representation on drawings
        - a. Notation
        - b. Dimensions
        - c. Graphical representation
            - (1) Detail drawings
            - (2) Assembly drawings
    - 2. Design worm gear drive systems
        - a. Compute power-transmitting capacity
        - b. Select drive components from supplier catalogs
        - c. Determine assembly methods for drive system components

III. Discuss Belt Drives

- A. Discuss belt drive terminology
- B. Discuss flat belts
    - 1. Discuss method of representation on drawings
        - a. Notation
        - b. Dimensions
        - c. Graphical representation
    - 2. Design flat belt drive systems
        - a. Compute power-transmitting capacity
        - b. Select drive components from supplier catalogs
        - c. Determine assembly methods for drive system components
- C. Discuss V-belts
    - 1. Discuss method of representation on drawings
        - a. Notation
        - b. Dimensions
        - c. Graphical representation
    - 2. Design V-belt drive systems
        - a. Compute power-transmitting capacity
        - b. Select drive components from supplier catalogs
        - c. Determine assembly methods for drive system components

IV. Discuss Chain Drives

- A. Discuss chain drive terminology
- B. Discuss basic types of chains: detachable, pintle, offset-sidebar, roller, double-pitch, inverted-tooth silent, bead (slider)

- C. Discuss sprockets
- D. Design roller chain drives
  1. Compute power-transmitting capacity
  2. Select drive components from supplier catalogs
  3. Determine assembly methods for drive system components
- E. Discuss method of representation on drawings
  1. Notation
  2. Dimensions
  3. Graphical representation

V. Discuss Couplings

- A. Define coupling: mechanical device used to connect two shafts.
- B. Discuss types of couplings
  1. Solid coupling
  2. Flexible coupling
  3. Universal coupling
  4. Flexible shafts
- C. Discuss application parameters: shaft alignment, operating conditions, dynamic forces, etc.
- D. Compute required strength capacity
- E. Select coupling components from supplier catalogs
- F. Determine assembly methods for coupling system components

VI. Discuss Cams

- A. Discuss cam terminology
- B. Discuss cam applications
- C. Discuss types of cam configurations
  1. Discuss plate cams
  2. Discuss translation cams
  3. Discuss positive-motion cams
  4. Discuss cylindrical cams
- D. Discuss types of cam motions
  1. Discuss uniform motion (constant velocity)
     - a. Compute motion characteristics
     - b. Design cam displacement diagram
  2. Discuss parabolic motion
     - a. Compute motion characteristics
     - b. Design cam displacement diagram
  3. Discuss harmonic motion
     - a. Compute motion characteristics
     - b. Design cam displacement diagram
  4. Discuss cycloidal motion
     - a. Compute motion characteristics
     - b. Design cam displacement diagram
  5. Discuss other motion types: modified trapezoidal motion, modified sine-curve motion
     - a. Compute motion characteristics

        - b. Design cam displacement diagram
- E. Design cam drive systems
    - 1. Compute power-transmitting capacity
    - 2. Select drive components from supplier catalogs
    - 3. Determine assembly methods for drive system components
- F. Discuss method of representing cams on drawings
    - 1. Notation
    - 2. Dimensions
    - 3. Graphical representation
        - a. Detail drawings
        - b. Assembly drawings

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Select appropriate components given necessary system specifications (include all necessary drawings, i.e., detail drawings and assembly drawings with full dimensions; show all computations):

- (1) Gear drives systems;
- (2) Chain drives systems;
- (3) Belt drives systems; and,
- (4) Cam systems.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E4) dealing with utilizing bearings for mechanical applications.

CAD-E3-HO
Utilize Power Transmission Elements for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

- a. Select appropriate power transmission elements for application;
- b. Understand basic power transmission element analysis;
- c. Identify types of power transmission elements; and,
- d. Use supplier catalogs and standard references to select power transmission elements for mechanical applications.

Module Outline:

- I. Define "Power Transmission Element": Machine Element Used in the Transmission of Power from One Location to Another
- II. Discuss Gear Drives
    - A. Discuss gear terminology
    - B. Discuss spur gears
        - 1. Discuss method of representation on drawings
            - a. Notation
            - b. Dimensions
            - c. Graphical representation
                - (1) Detail drawings
                - (2) Assembly drawings
        - 2. Design spur gear drive systems
            - a. Compute power-transmitting capacity
            - b. Select drive components from supplier catalogs
            - c. Determine assembly methods for drive system components
    - C. Discuss rack and pinion gears
        - 1. Discuss method of representation on drawings
            - a. Notation
            - b. Dimensions
            - c. Graphical representation
                - (1) Detail drawings
                - (2) Assembly drawings
        - 2. Design rack and pinion gear drive systems
            - a. Compute power-transmitting capacity
            - b. Select drive components from supplier catalogs
            - c. Determine assembly methods for drive system components
    - D. Discuss bevel gears

    1. Discuss method of representation on drawings
      a. Notation
      b. Dimensions
      c. Graphical representation
        (1) Detail drawings
        (2) Assembly drawings
    2. Design bevel gear drive systems
      a. Compute power-transmitting capacity
      b. Select drive components from supplier catalogs
      c. Determine assembly methods for drive system components
  E. Discuss worm and worm gears
    1. Discuss method of representation on drawings
      a. Notation
      b. Dimensions
      c. Graphical representation
        (1) Detail drawings
        (2) Assembly drawings
    2. Design worm gear drive systems
      a. Compute power-transmitting capacity
      b. Select drive components from supplier catalogs
      c. Determine assembly methods for drive system components
III. Discuss Belt Drives
  A. Discuss belt drive terminology
  B. Discuss flat belts
    1. Discuss method of representation on drawings
      a. Notation
      b. Dimensions
      c. Graphical representation
    2. Design flat belt drive systems
      a. Compute power-transmitting capacity
      b. Select drive components from supplier catalogs
      c. Determine assembly methods for drive system components
  C. Discuss V-belts
    1. Discuss method of representation on drawings
      a. Notation
      b. Dimensions
      c. Graphical representation
    2. Design V-belt drive systems
      a. Compute power-transmitting capacity
      b. Select drive components from supplier catalogs
      c. Determine assembly methods for drive system components

IV. Discuss Chain Drives
  A. Discuss chain drive terminology
  B. Discuss basic types of chains: detachable, pintle, offset-sidebar, roller, double-pitch, inverted-tooth silent, bead (slider)
  C. Discuss sprockets
  D. Design roller chain drives
    1. Compute power-transmitting capacity
    2. Select drive components from supplier catalogs
    3. Determine assembly methods for drive system components
  E. Discuss method of representation on drawings
    1. Notation
    2. Dimensions
    3. Graphical representation

V. Discuss Couplings
  A. Define coupling: mechanical device used to connect two shafts.
  B. Discuss types of couplings
    1. Solid coupling
    2. Flexible coupling
    3. Universal coupling
    4. Flexible shafts
  C. Discuss application parameters: shaft alignment, operating conditions, dynamic forces, etc.
  D. Compute required strength capacity
  E. Select coupling components from supplier catalogs
  F. Determine assembly methods for coupling system components

VI. Discuss Cams
  A. Discuss cam terminology
  B. Discuss cam applications
  C. Discuss types of cam configurations
    1. Discuss plate cams
    2. Discuss translation cams
    3. Discuss positive-motion cams
    4. Discuss cylindrical cams
  D. Discuss types of cam motions
    1. Discuss uniform motion (constant velocity)
      a. Compute motion characteristics
      b. Design cam displacement diagram
    2. Discuss parabolic motion
      a. Compute motion characteristics
      b. Design cam displacement diagram
    3. Discuss harmonic motion
      a. Compute motion characteristics
      b. Design cam displacement diagram
    4. Discuss cycloidal motion
      a. Compute motion characteristics

        - b. Design cam displacement diagram
    - 5. Discuss other motion types: modified trapezoidal motion, modified sine-curve motion
        - a. Compute motion characteristics
        - b. Design cam displacement diagram
- E. Design cam drive systems
    - 1. Compute power-transmitting capacity
    - 2. Select drive components from supplier catalogs
    - 3. Determine assembly methods for drive system components
- F. Discuss method of representing cams on drawings
    - 1. Notation
    - 2. Dimensions
    - 3. Graphical representation
        - a. Detail drawings
        - b. Assembly drawings

CAD-E3-LE
Utilize Power Transmission Elements for Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Select appropriate components given necessary system specifications (include all necessary drawings, i.e., detail drawings and assembly drawings with full dimensions; show all computations):
   - (1) Gear drives systems;
   - (2) Chain drives systems;
   - (3) Belt drives systems; and,
   - (4) Cam systems.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E4

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Utilize Bearings for Mechanical Applications

Objective(s)

Upon completion of this unit the student will be able to:
a. Identify types of bearing devices;
b. Understand basic bearing device analysis;
c. Select appropriate bearing devices for application; and,
d. Use supplier catalogs and standard references to select bearing devices for mechanical applications.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E4-HO)
MASTER Laboratory Exercise (CAD-E4-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition

Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-E1 "Understand Basic Design Procedures"
CAD-E2 "Utilize Fasteners for Mechanical Applications"
CAD-E3 "Utilize Power Transmission Elements for Mechanical Applications"

Introduction:

Bearings can be found in every machine with moving parts. Because they are so common, a mechanical designer must be comfortable with working with them. This includes computing the various dynamic and static characteristics of the system, determining the type of bearing that would work best with the given system, selecting the bearings based on those calculations, and completing the detail and assembly drawings with the bearings.

Presentation Outline:

I. Define "Bearing:" Device Used to Permit Smooth, Low Friction Motion Between Two Surfaces

II. Discuss Major Types of Bearings
   A. Plain bearings
      1. Journal (sleeve) bearings
      2. Thrust bearings
   B. Ball bearings
      1. Radial bearings
      2. Thrust bearings
   C. Roller bearings
      1. Cylindrical bearings
      2. Needle bearings
      3. Tapered bearings
      4. Spherical bearings

III. Discuss Typical Applications of Bearings
   A. Radial loads
   B. Thrust loads
   C. Combination loads

IV. Compute Operating Conditions (In the Following Order)
   A. Compute life of bearings - use life-expectancy curves (from bearing supplier)
   B. Compute load on bearings
      1. Compute static load
      2. Compute dynamic load
   C. Compute speed (rpm) of shaft

V. Select Appropriate Bearing Based on Operating Conditions (see IV. A, B, C above)

VI. Determine Fit Specifications Between Bearing and Mating Parts (Shaft, Housing, Etc.) (From Bearing Supplier)

VII. Discuss the Required Drawings for a Bearing Assembly
   A. Draw shaft detail drawing with tolerance dimensions
   B. Draw housing detail drawing with tolerance dimensions
   C. Draw assembly drawing showing bearings, shaft and housing

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Select proper bearings for a system given the operating conditions. Students must compute the life-load-speed characteristics of the system, then use bearing supplier catalogs to make a selection. A complete drawing set (shaft and housing detail, shaft/housing/bearing assembly) should also be included with full tolerance dimensions.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E5) dealing with understanding basic manufacturing methods.

CAD-E4-HO
Utilize Bearings For Mechanical Applications
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

a. Identify types of bearing devices;
b. Understand basic bearing device analysis;
c. Select appropriate bearing devices for application; and,
d. Use supplier catalogs and standard references to select bearing devices for mechanical applications.

Module Outline:

I. Define "Bearing:" Device Used to Permit Smooth, Low Friction Motion Between Two Surfaces
II. Discuss Major Types of Bearings
    A. Plain bearings
        1. Journal (sleeve) bearings
        2. Thrust bearings
    B. Ball bearings
        1. Radial bearings
        2. Thrust bearings
    C. Roller bearings
        1. Cylindrical bearings
        2. Needle bearings
        3. Tapered bearings
        4. Spherical bearings
III. Discuss Typical Applications of Bearings
    A. Radial loads
    B. Thrust loads
    C. Combination loads
IV. Compute Operating Conditions (In the Following Order)
    A. Compute life of bearings - use life-expectancy curves (from bearing supplier)
    B. Compute load on bearings
        1. Compute static load
        2. Compute dynamic load
    C. Compute speed (rpm) of shaft
V. Select Appropriate Bearing Based on Operating Conditions (see IV. A, B, C above)
VI. Determine Fit Specifications Between Bearing and Mating Parts (Shaft, Housing, Etc.) (From Bearing Supplier)

VII. Discuss the Required Drawings for a Bearing Assembly
  A. Draw shaft detail drawing with tolerance dimensions
  B. Draw housing detail drawing with tolerance dimensions
  C. Draw assembly drawing showing bearings, shaft and housing

CAD-E4-LE
Utilize Bearings For Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Select proper bearings for a system given the operating conditions. Students must compute the life-load-speed characteristics of the system, then use bearing supplier catalogs to make a selection. A complete drawing set (shaft and housing detail, shaft/housing/bearing assembly) should also be included with full tolerance dimensions.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E5

Subject: Computer-Aided Drafting & Design **Time: 5 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Understand Basic Manufacturing Methods

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of manufacturing operations;
b. Understand application of manufacturing in drafting and design of machinery; and,
c. Prepare drawings for manufacturing applications.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E5-HO)
MASTER Laboratory Exercise (CAD-E5-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-E1 "Understand Basic Design Procedures"

Introduction:

Any design is ultimately beholden to the specific manufacturing operation that is to be used to produce the object. The shape of the object and the necessary dimensions are greatly affected by the type of production operations it will undergo.

Presentation Outline:

- I. Discuss Types of Manufacturing Operations
  - A. Discuss Machining operations
    - 1. Define machining: Metal removal process using sharp tools. Produces flat, smooth (relatively) surface.
    - 2. Discuss types of machining operations
      - a. End milling/face milling – rotating tool cuts surface of metal
      - b. Machine lathe – tool is stationary (except for radial motion) and the workpiece (metal) rotates
      - c. CNC machining – "computer-numerical control" machine tool is controlled by computer code detailing each successive cutting operation
    - 3. Discuss drafting considerations
      - a. Discuss surface finish marks
      - b. Discuss machining datum surfaces
      - c. Discuss shape of surface after machining
        - (1) Tool creates sharp edges and corners
        - (2) Interior corner radius limited by geometry of tool
        - (3) Surfaces are flat
  - B. Discuss metal casting
    - 1. Define casting: production of parts by pouring molten metal into a mold.
    - 2. Discuss types of casting operations
      - a. Sand mold casting
      - b. Shell mold casting
      - c. Plaster mold casting
      - d. Permanent mold casting
      - e. Investment mold casting
      - f. Full mold casting
      - g. Centrifugal casting
      - h. Continuous casting
      - i. Die casting
    - 3. Discuss design considerations
      - a. Discuss metal solidification in castings
      - b. Discuss casting design rules
    - 4. Discuss drafting practices
      - a. Discuss the casting drawing
      - b. Discuss casting tolerances
      - c. Discuss machining allowances and tolerances
      - d. Discuss draft angles
      - e. Discuss parting lines
      - f. Discuss casting datums

C. Discuss forging operations
  1. Define forging: plastically deforming a heated piece of metal into a predetermined shape using a specially shaped press.
  2. Discuss forging design and drafting considerations
    a. Discuss the forging drawing
    b. Discuss forging tolerances
    c. Discuss machining allowances and tolerances
    d. Discuss draft angles
    e. Discuss parting lines
    f. Discuss forging datums

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions
b) Create a casting drawing and detail (machining) drawing based on given design specifications. Include all necessary casting tolerances and datums.
c) Create a forging drawing and detail (machining) drawing based on given design specifications. Include all necessary forging tolerances and datums.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E6) dealing with utilizing brakes and clutches for mechanical applications.

CAD-E5-HO
Understand Basic Manufacturing Methods
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify types of manufacturing operations;
- b. Understand application of manufacturing in drafting and design of machinery; and,
- c. Prepare drawings for manufacturing applications.

Module Outline:

- I. Discuss Types of Manufacturing Operations
  - A. Discuss Machining operations
    - 1. Define machining: Metal removal process using sharp tools. Produces flat, smooth (relatively) surface.
    - 2. Discuss types of machining operations
      - a. End milling/face milling – rotating tool cuts surface of metal
      - b. Machine lathe – tool is stationary (except for radial motion) and the workpiece (metal) rotates
      - c. CNC machining – "computer-numerical control" machine tool is controlled by computer code detailing each successive cutting operation
    - 3. Discuss drafting considerations
      - a. Discuss surface finish marks
      - b. Discuss machining datum surfaces
      - c. Discuss shape of surface after machining
        - (1) Tool creates sharp edges and corners
        - (2) Interior corner radius limited by geometry of tool
        - (3) Surfaces are flat
  - B. Discuss metal casting
    - 1. Define casting: production of parts by pouring molten metal into a mold.
    - 2. Discuss types of casting operations
      - a. Sand mold casting
      - b. Shell mold casting
      - c. Plaster mold casting
      - d. Permanent mold casting
      - e. Investment mold casting
      - f. Full mold casting

        g. Centrifugal casting
        h. Continuous casting
        i. Die casting
    3. Discuss design considerations
        a. Discuss metal solidification in castings
        b. Discuss casting design rules
    4. Discuss drafting practices
        a. Discuss the casting drawing
        b. Discuss casting tolerances
        c. Discuss machining allowances and tolerances
        d. Discuss draft angles
        e. Discuss parting lines
        f. Discuss casting datums

C. Discuss forging operations
    1. Define forging: plastically deforming a heated piece of metal into a predetermined shape using a specially shaped press.
    2. Discuss forging design and drafting considerations
        a. Discuss the forging drawing
        b. Discuss forging tolerances
        c. Discuss machining allowances and tolerances
        d. Discuss draft angles
        e. Discuss parting lines
        f. Discuss forging datums

CAD-E5-LE
Understand Basic Manufacturing Methods
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) **Answer review questions**

b) **Create a casting drawing and detail (machining) drawing based on given design specifications. Include all necessary casting tolerances and datums.**

c) **Create a forging drawing and detail (machining) drawing based on given design specifications. Include all necessary forging tolerances and datums.**

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E6

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Utilize Brakes and Clutches for Mechanical Applications

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Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of brakes and clutches;
b. Understand basic brake and clutch analysis; and,
c. Select appropriate brakes and clutches for application.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E6-HO)
MASTER Laboratory Exercise (CAD-E6-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-E1	"Understand Basic Design Procedures"
CAD-E2	"Utilize Fasteners for Mechanical Applications"
CAD-E3	"Utilize Power Transmission Elements for Mechanical Applications"
CAD-E4	"Utilize Bearings for Mechanical Applications"

Introduction:

Brakes and clutches are an integral component in any machine with rotating parts. The application of a brake or clutch into a design brings with it many additional

variables, such as thermal, power, and strength considerations. Therefore, the proper selection of a brake or clutch can determine the overall effectiveness of a design.

Presentation Outline:

I. Discuss brakes
  A. Discuss brake terminology
  B. Discuss brake analysis
    1. Compute force-moment analysis
    2. Create free-body diagram
    3. Discuss frictional considerations
    4. Discuss thermal considerations
  C. Discuss types of brakes
    1. Discuss block brakes
    2. Discuss band brakes
    3. Discuss drum brakes
    4. Discuss caliper brakes
    5. Discuss disc brakes
  D. Discuss design considerations
    1. Compute brake parameters based on design analysis
    2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis
II. Discuss clutches
  A. Discuss clutch terminology
  B. Discuss clutch analysis
    1. Compute force-moment analysis
    2. Create free-body diagram
    3. Compute torque capacity
    4. Discuss frictional considerations
    5. Discuss thermal considerations
  C. Discuss types of clutches
    1. Discuss jaw clutches
    2. Discuss plate clutches
    3. Discuss cone clutches
    4. Discuss spring clutches
    5. Discuss over-running clutches
    6. Discuss electric clutches
    7. Discuss dry fluid clutches
  D. Discuss design considerations
    1. Compute clutch parameters based on design analysis
    2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;
b) Select appropriate brake and brake components given necessary system specifications. Show all computations. Prepare an assembly drawing of system; and,
c) Select appropriate clutch and clutch components given necessary system specifications. Show all computations. Prepare an assembly drawing of system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-E7) dealing with designing shafts for use in mechanical applications.

CAD-E6-HO
Utilize Brakes and Clutches for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify types of brakes and clutches;
b. Understand basic brake and clutch analysis; and,
c. Select appropriate brakes and clutches for application.

Module Outline:

I. Discuss brakes
  A. Discuss brake terminology
  B. Discuss brake analysis
    1. Compute force-moment analysis
    2. Create free-body diagram
    3. Discuss frictional considerations
    4. Discuss thermal considerations
  C. Discuss types of brakes
    1. Discuss block brakes
    2. Discuss band brakes
    3. Discuss drum brakes
    4. Discuss caliper brakes
    5. Discuss disc brakes
  D. Discuss design considerations
    1. Compute brake parameters based on design analysis
    2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis
II. Discuss clutches
  A. Discuss clutch terminology
  B. Discuss clutch analysis
    1. Compute force-moment analysis
    2. Create free-body diagram
    3. Compute torque capacity
    4. Discuss frictional considerations
    5. Discuss thermal considerations
  C. Discuss types of clutches
    1. Discuss jaw clutches
    2. Discuss plate clutches
    3. Discuss cone clutches
    4. Discuss spring clutches
    5. Discuss over-running clutches

    6. Discuss electric clutches
    7. Discuss dry fluid clutches

D. Discuss design considerations
    1. Compute clutch parameters based on design analysis
    2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis

CAD-E6-LE
Utilize Brakes and Clutches for Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Select appropriate brake and brake components given necessary system specifications. Show all computations. Prepare an assembly drawing of system; and,

c) Select appropriate clutch and clutch components given necessary system specifications. Show all computations. Prepare an assembly drawing of system.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-E7

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Assist Engineering Personnel**
Task: Design Shafts for Use in Mechanical Applications

Objective(s):

Upon completion of this unit the student will be able to:
a. Understand basic shaft analysis;
b. Select appropriate shafts for applications; and,
c. Use shafts in the design.

Instructional Materials:

Textbook (see References for suitable texts)
MASTER Handout (CAD-E7-HO)
MASTER Laboratory Exercise (CAD-E7-LE)

References:

Machine Design, Esposito, A., Thrower, J., Delmar Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-E1 "Understand Basic Design Procedures"

Introduction:

Shafts are used in every machine that transmits power from one location or source to another. The proper design of transmission shafting is critical, and there are many variables to be taken into consideration. The failure of a shaft during operation can have serious consequences to the performance of the machine and safety of the operating personnel.

Presentation Outline:

- I. Define Shaft: Rotating Cylindrical Member Designed to Transmit Torque
  - A. Define axle: non-rotating shaft
- II. Discuss Terminology: Torque, Moment, Power, Stress, Shear Stress, Stress Types
- III. Discuss Standard Shafting
  - A. Discuss standard materials
  - B. Discuss production of shafts
  - C. Discuss machining of shafts
- IV. Discuss shaft analysis
  - A. Discuss deflection of shaft
    - 1. Define shaft deflection
    - 2. Discuss forces involved in shaft deflection
  - B. Discuss torsion of shaft
    - 1. Define shaft torsion
    - 2. Discuss forces involved in shaft torsion
  - C. Discuss shear
    - 1. Define shear
    - 2. Discuss forces involved in shaft shear
  - D. Compute simple relationships
    - 1. Compute stress given shaft properties
    - 2. Compute power given shaft properties
    - 3. Compute torsional stress given shaft properties
    - 4. Compute critical speed given shaft properties
  - E. Design shaft for torsional stiffness
    - 1. Compute polar moment of inertia (J) (use tables)
    - 2. Compute torque (T) from operating conditions
    - 3. Compute Modulus of Rigidity (G) given shaft properties
    - 4. Compute angular deflection of shaft (θ) using T, G, J and shaft length (l)
    - 5. Compute minimum shaft diameter using T, G, θ, and shaft properties
    - 6. Select shaft based on minimum diameter requirement
  - F. Design shaft for bending stiffness
    - 1. Create loading diagram (free-body diagram)
    - 2. Compute force-moment-torque values
    - 3. Compute Modulus of Elasticity (E)
    - 4. Compute Moment of Inertia (I)
    - 5. Compute maximum bending moment (use tables)
    - 6. Use the Principle of Superposition to find deflection values
    - 7. Create shear and moment diagrams
    - 8. Compute fatigue stress coefficients based on operating conditions and shaft properties

        9. Compute minimum diameter based on above calculations, operating conditions, and shaft properties.
    G. Design shaft for combined loading (torsion and bending)
        1. Demonstrate the procedure for using the Equivalent Torque Method
        2. Demonstrate the procedure for using the Equivalent Bending Moment Method
    H. Discuss the effects of keys, splines, and couplings on shafts
V. Demonstrate the Procedure for Creating a Detail Drawing of the Shaft
    A. Discuss standard methods for attaching machine elements to shafts (keys, splines, collars, taper fits, press fits, pins, retaining rings, etc.)
    B. Compute the fits and tolerances needed on the shaft
        1. Discuss fitting bearings
        2. Discuss fitting gears
        3. Discuss fitting keys, splines, other fasteners
        4. Discuss fitting other machine elements

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Design a shaft given operating conditions and system requirements. Create a detail drawing with proper tolerances for all attached machine elements.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This is the last technical module under Duty E: Assist Engineering Personnel. The next duty is F: Use Computer-Aided Drafting System, and the first **MASTER Technical Module is CAD-F1**: Start and Exit Software Program.

CAD-E7-HO
Design Shafts For Use in Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand basic shaft analysis;
b. Select appropriate shafts for applications; and,
c. Use shafts in the design.

Module Outline:

I. Define Shaft: Rotating Cylindrical Member Designed to Transmit Torque
    A. Define axle: non-rotating shaft
II. Discuss Terminology: Torque, Moment, Power, Stress, Shear Stress, Stress Types
III. Discuss Standard Shafting
    A. Discuss standard materials
    B. Discuss production of shafts
    C. Discuss machining of shafts
IV. Discuss shaft analysis
    A. Discuss deflection of shaft
        1. Define shaft deflection
        2. Discuss forces involved in shaft deflection
    B. Discuss torsion of shaft
        1. Define shaft torsion
        2. Discuss forces involved in shaft torsion
    C. Discuss shear
        1. Define shear
        2. Discuss forces involved in shaft shear
    D. Compute simple relationships
        1. Compute stress given shaft properties
        2. Compute power given shaft properties
        3. Compute torsional stress given shaft properties
        4. Compute critical speed given shaft properties
    E. Design shaft for torsional stiffness
        1. Compute polar moment of inertia (J) (use tables)
        2. Compute torque (T) from operating conditions
        3. Compute Modulus of Rigidity (G) given shaft properties
        4. Compute angular deflection of shaft (θ) using T, G, J and shaft length (l)
        5. Compute minimum shaft diameter using T, G, θ, and shaft properties

        - 6. Select shaft based on minimum diameter requirement
    - F. Design shaft for bending stiffness
        - 1. Create loading diagram (free-body diagram)
        - 2. Compute force-moment-torque values
        - 3. Compute Modulus of Elasticity (E)
        - 4. Compute Moment of Inertia (I)
        - 5. Compute maximum bending moment (use tables)
        - 6. Use the Principle of Superposition to find deflection values
        - 7. Create shear and moment diagrams
        - 8. Compute fatigue stress coefficients based on operating conditions and shaft properties
        - 9. Compute minimum diameter based on above calculations, operating conditions, and shaft properties.
    - G. Design shaft for combined loading (torsion and bending)
        - 1. Demonstrate the procedure for using the Equivalent Torque Method
        - 2. Demonstrate the procedure for using the Equivalent Bending Moment Method
    - H. Discuss the effects of keys, splines, and couplings on shafts
- V. Demonstrate the Procedure for Creating a Detail Drawing of the Shaft
    - A. Discuss standard methods for attaching machine elements to shafts (keys, splines, collars, taper fits, press fits, pins, retaining rings, etc.)
    - B. Compute the fits and tolerances needed on the shaft
        - 1. Discuss fitting bearings
        - 2. Discuss fitting gears
        - 3. Discuss fitting keys, splines, other fasteners
        - 4. Discuss fitting other machine elements

CAD-E7-LE
Design Shafts For Use in Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Design a shaft given operating conditions and system requirements. Create a detail drawing with proper tolerances for all attached machine elements.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... **plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.**

	Duties	Tasks												
A	**Apply Mathematical Concepts**	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	**Demonstrate Fundamental Drafting Skills**	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	**Plan and Organize Activities**	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	**Prepare Mechanical Production Drawings**	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	**Assist Engineering Personnel**	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	**Use Computer-Aided Drafting System**	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F1

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Start and Exit a Software Program

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand starting procedures; and,
- b. Understand exiting procedures.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F1-HO)
MASTER Laboratory Exercise (CAD-F1-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

This is an introductory level Technical Module; therefore, there are no prerequisite technical modules.

Introduction:

This technical module begins a three-part series (CAD-F1, CAD-F2, CAD-F3) intended to provide the student with enough knowledge of a computer system to effectively use a computer-aided drafting program.

Presentation Outline:

I. Introduction to Computer Components
  A. Introduce main components
    1. CPU and drive bays (3.5", 5.25", CD, etc.)

        - 2. Monitor
        - 3. Mouse/digitizer puck
        - 4. Keyboard
    - B. Introduce peripherals (if applicable)
        - 1. Printers/plotters
        - 2. Document scanners
        - 3. Digitizer
- II. Turn Computer (and Components) "On"
    - A. Locate and activate the POWER button on the computer or power supply
    - B. If necessary, locate and activate the POWER buttons on any additional components (monitor, printer, etc.)
      NOTE: Depending on the specific computer arrangement in the classroom the following may or may not apply.
    - C. Log onto the computer network
    - D. Start computer operating system (OS)
      NOTE: The presentation of the following topics will depend on the type of operating system and CAD software being used. The following sub-topics are general and may or may not apply in all cases.
- III. Start CAD (or Other) Program
    - A. Type the program executable file name (including directory paths) on the command line (DOS)
    - B. Double-click on the program icon (Windows 3.x, Windows 95, Windows NT)
- IV. Exit CAD (or Other) Program
- V. Turn Computer (and Components) "Off"
    - A. If applicable, exit OS (Windows 3.x, Windows 95, Windows NT)
    - B. If applicable, log out of network
    - C. Turn off the computer or power supply
    - D. Turn off any additional equipment

Practical Application:

Students must demonstrate the skills described above by performing the required steps to start a computer program beginning with the computer turned "off". Students should repeat these activities until the instructor is satisfied that the skills have been mastered.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F2) in which the students will use the computer skills developed in this technical module to perform basic file management routines.

CAD-F1-HO
Start and Exit a Software Program
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand starting procedures; and,
- b. Understand exiting procedures.

Module Outline:

- I. Introduction to Computer Components
  - A. Introduce main components
    - 1. CPU and drive bays (3.5", 5.25", CD, etc.)
    - 2. Monitor
    - 3. Mouse/digitizer puck
    - 4. Keyboard
  - B. Introduce peripherals (if applicable)
    - 1. Printers/plotters
    - 2. Document scanners
    - 3. Digitizer
- II. Turn Computer (and Components) "On"
  - A. Locate and activate the POWER button on the computer or power supply
  - B. If necessary, locate and activate the POWER buttons on any additional components (monitor, printer, etc.)

    NOTE: Depending on the specific computer arrangement in the classroom the following may or may not apply.
  - C. Log onto the computer network
  - D. Start computer operating system (OS)

    NOTE: The presentation of the following topics will depend on the type of operating system and CAD software being used. The following sub-topics are general and may or may not apply in all cases.
- III. Start CAD (or Other) Program
  - A. Type the program executable file name (including directory paths) on the command line (DOS)
  - B. Double-click on the program icon (Windows 3.x, Windows 95, Windows NT)
- IV. Exit CAD (or Other) Program
- V. Turn Computer (and Components) "Off"
  - A. If applicable, exit OS (Windows 3.x, Windows 95, Windows NT)
  - B. If applicable, log out of network
  - C. Turn off the computer or power supply
  - D. Turn off any additional equipment

CAD-F1-LE
Start and Exit a Software Program
Attachment 2: MASTER Laboratory Exercise

Students must demonstrate the skills described above by performing the required steps to start a computer program beginning with the computer turned "off". Students should repeat these activities until the instructor is satisfied that the skills have been mastered.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F2

Subject: Computer-Aided Drafting & Design **Time:** 1 Hr.

Duty: Use Computer-Aided Drafting System
Task: Demonstrate Proper File Management Techniques

Objective(s):

Upon completion of this unit the student will be able to:

a. Explain file management techniques;
b. Demonstrate file management procedures; and,
c. Format a floppy disk.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F2-HO)
MASTER Laboratory Exercise (CAD-F2-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-F1 "Start and Exit a Software Program"

Introduction:

The student must have demonstrable knowledge in the directory structure of a computer in order to effectively use any program. Knowledge of directory structures allows the student to manipulate files according to time and date, revision number, and location, thus minimizing the loss of data and maximizing the efficiency of the computer directory structure.

Presentation Outline:

- I. Discuss Computer Directory Structure
  - A. Directory structure on a personal computer (PC)
    - 1. Hard drive - root and sub-directories
    - 2. Floppy drive
  - B. Directory structure on a computer network (user account only)
- II. Manage Directories
  - A. Create sub-directory from root directory
  - B. Create sub-directory from sub-directory
  - C. List files in directory
  - D. Delete sub-directories
- III. Manage Files
  - A. Copy file from directories on hard drive
  - B. Copy file from hard drive to floppy disk
  - C. Rename files
  - D. Delete file
- IV. Format Floppy Disk (With and Without System Files)

Practical Application:

Students will be given classwork assignments in which they must:

- a) Create sub-directories on the hard drive (or in their user account on the network);
- b) Format a floppy disk;
- c) Create sub-directories on a floppy disk;
- d) Copy files from directories on hard drive;
- e) Copy files from hard drive to floppy disk (and vice versa);
- f) Delete files; and,
- g) Rename files.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F3) in which the students will use the computer skills developed in technical modules CAD-F1 and CAD-F2 to perform directory structure routines.

CAD-F2-HO
Demonstrate Proper File Management Techniques
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Explain file management techniques;
b. Demonstrate file management procedures; and,
c. Format a floppy disk.

Module Outline:

I. Discuss Computer Directory Structure
    A. Directory structure on a personal computer (PC)
        1. Hard drive - root and sub-directories
        2. Floppy drive
    B. Directory structure on a computer network (user account only)
II. Manage Directories
    A. Create sub-directory from root directory
    B. Create sub-directory from sub-directory
    C. List files in directory
    D. Delete sub-directories
III. Manage Files
    A. Copy file from directories on hard drive
    B. Copy file from hard drive to floppy disk
    C. Rename files
    D. Delete file
IV. Format Floppy Disk (With and Without System Files)

CAD-F2-LE
Demonstrate Proper File Management Techniques
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork assignments in which they must:

a) Create sub-directories on the hard drive (or in their user account on the network);
b) Format a floppy disk;
c) Create sub-directories on a floppy disk;
d) Copy files from directories on hard drive;
e) Copy files from hard drive to floppy disk (and vice versa);
f) Delete files; and,
g) Rename files.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F3

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Directory Structure

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify directories and sub-directories; and,
b. Create and delete directories.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F3-HO)
MASTER Laboratory Exercise (CAD-F3-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:
CAD-F1 "Start and Exit a Software Program"
CAD-F2 "Demonstrate Proper File Management Techniques"

Introduction:

The ability to perform basic computer management operations is essential if one is to work daily with computers. In this section, the student will learn how to create directories, which can be used to separate and store important files. Computer file directories should be viewed analogously to a paper filing system. Proper filing is crucial to the organization of a CAD system.

Presentation Outline:

I. Define *Directory*: a Computer Directory, Also Referred to as a Sub-directory or Folder, Is an Area on the Computer Hard Disk Created by the User Which Is Set Aside to Store Specific Files. It Is Analogous to the File Folder System Used with Filing Cabinets, Where Each Computer Directory Represents a Separate File Folder and the Computer Files Correspond to the Papers Stored in the File Folders.

II. Using a File Viewing Program (such as Windows Explorer), Examine Directories/sub-directories on the Computer Hard Drive
- A. Demonstrate the method for expanding the directory tree to show all sub-directories under a selected directory
- B. Demonstrate the method for compacting the directory tree to hide all sub-directories under a selected directory

III. Using a File Viewing Program (such as Windows Explorer), Create a Sub-directory on the Computer Hard Drive
- A. Discuss acceptable characters for use in directory names
- B. Discuss acceptable length of directory names
- C. Discuss case-sensitivity
- D. Demonstrate the method for setting/changing properties of a directory
  - 1. Read-only
  - 2. Hidden
  - 3. Archive
- E. Demonstrate procedure for renaming a directory

IV. Using a File Viewing Program (such as Windows Explorer), Copy And/or Move a File from One Directory into Another

V. Using a File Viewing Program (such as Windows Explorer), Delete a File from a Directory

VI. Using a File Viewing Program (such as Windows Explorer), Delete a Sub-directory on the Computer Hard Drive
- A. Demonstrate procedure for deleting a single sub-directory
- B. Demonstrate procedure for deleting a sub-directory and all directories under that sub-directories

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Students should be given assignments in which they must create, rename, copy files into, and delete a sub-directory.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F4) dealing with opening, saving, and exiting a drawing file.

CAD-F3-HO
Use Directory Structure
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify directories and sub-directories; and,
b. Create and delete directories.

Module Outline:

I. Define *Directory*: a Computer Directory, Also Referred to as a Sub-directory or Folder, Is an Area on the Computer Hard Disk Created by the User Which Is Set Aside to Store Specific Files. It Is Analogous to the File Folder System Used with Filing Cabinets, Where Each Computer Directory Represents a Separate File Folder and the Computer Files Correspond to the Papers Stored in the File Folders.

II. Using a File Viewing Program (such as Windows Explorer), Examine Directories/sub-directories on the Computer Hard Drive
    A. Demonstrate the method for expanding the directory tree to show all sub-directories under a selected directory
    B. Demonstrate the method for compacting the directory tree to hide all sub-directories under a selected directory

III. Using a File Viewing Program (such as Windows Explorer), Create a Sub-directory on the Computer Hard Drive
    A. Discuss acceptable characters for use in directory names
    B. Discuss acceptable length of directory names
    C. Discuss case-sensitivity
    D. Demonstrate the method for setting/changing properties of a directory
        1. Read-only
        2. Hidden
        3. Archive
    E. Demonstrate procedure for renaming a directory

IV. Using a File Viewing Program (such as Windows Explorer), Copy And/or Move a File from One Directory into Another

V. Using a File Viewing Program (such as Windows Explorer), Delete a File from a Directory

VI. Using a File Viewing Program (such as Windows Explorer), Delete a Sub-directory on the Computer Hard Drive
    A. Demonstrate procedure for deleting a single sub-directory
    B. Demonstrate procedure for deleting a sub-directory and all directories under that sub-directories

CAD-F3-LE
Use Directory Structure
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Students should be given assignments in which they must create, rename, copy files into, and delete a sub-directory.

CAD-F4

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F4

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Open, Save, and Exit a Drawing File

Objective(s):

Upon completion of this unit the student will be able to:

a. Create a new drawing file;
b. Open an existing drawing file;
c. Save a drawing file; and,
d. Exit and save a drawing file.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F4-HO)
MASTER Laboratory Exercise (CAD-F4-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"

Introduction:

The most fundamental skill that a CAD drafter must possess is the ability to start and end a drawing session properly. This includes properly beginning a drawing and saving the file into a specific directory.

Presentation Outline:

I. Demonstrate Procedure for Starting the CAD Software
II. Demonstrate Procedure for Starting New CAD Drawing
  A. Use a previously created template when beginning a new drawing
  B. Create a new drawing without a template
III. Demonstrate Procedure for Opening Existing CAD Drawing
IV. Demonstrate Procedure for Saving Changes to the CAD Drawing
  A. Save with the current file name
  B. Save as a different file name (including directory location)
V. Demonstrate Procedure for Exiting the CAD Software
  A. Exit and save changes to CAD drawing
  B. Exit and save as another file name
  C. Quit the CAD drawing (exit and do not save changes to CAD drawing file)

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Demonstrate skills necessary for achieving educational objectives.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F5) dealing with utilizing drawing setup procedures.

CAD-F4-HO
Open, Save, and Exit a Drawing File
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Create a new drawing file;
- b. Open an existing drawing file;
- c. Save a drawing file; and,
- d. Exit and save a drawing file.

Module Outline:

- I. Demonstrate Procedure for Starting the CAD Software
- II. Demonstrate Procedure for Starting New CAD Drawing
  - A. Use a previously created template when beginning a new drawing
  - B. Create a new drawing without a template
- III. Demonstrate Procedure for Opening Existing CAD Drawing
- IV. Demonstrate Procedure for Saving Changes to the CAD Drawing
  - A. Save with the current file name
  - B. Save as a different file name (including directory location)
- V. Demonstrate Procedure for Exiting the CAD Software
  - A. Exit and save changes to CAD drawing
  - B. Exit and save as another file name
  - C. Quit the CAD drawing (exit and do not save changes to CAD drawing file)

CAD-F4-LE
Open, Save, and Exit a Drawing File
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Demonstrate skills necessary for achieving educational objectives.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F5

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Utilize Drawing Setup Procedures

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify drawing setup procedures; and,
b. Perform drawing setup.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F5-HO)
MASTER Laboratory Exercise (CAD-F5-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"

Introduction:

The first step when beginning a CAD drawing is to properly setup the drawing environment so that the program works properly and effectively. This is also the first step in standardizing the CAD drawing – to have every drawing begin with the identical startup settings.

Presentation Outline:

- I. Discuss Creation of Standard Layers for Mechanical Drawings
  - A. Each layer used for specific linetype:
    - 1. Visible lines
    - 2. Hidden lines
    - 3. Center lines
    - 4. Phantom lines
    - 5. Dimension lines
    - 6. Extension lines
    - 7. Border line
    - 8. Construction line
    - 9. Section line
    - 10. Text
    - 11. Other miscellaneous linetypes used during drafting
  - B. Each layer color controls the width of line during printing
- II. Discuss the Selection and Loading of the Linetypes Necessary for Mechanical Drawing
- III. Discuss the Inclusion of Internal Blocks Which May Be Used for the Following Purposes:
  - A. Borders (inch and metric sizes)
  - B. Title strips of various sizes (inch and metric sizes)
  - C. Revision blocks (corresponding to the various border sizes)
  - D. Bills of material (corresponding to the various border sizes)
  - E. Tolerance blocks (corresponding to the various border sizes)
  - F. Special symbols such as
    - 1. Mechanical parts
    - 2. Electrical symbols
    - 3. Dimension symbols
    - 4. Welding symbols
    - 5. HVAC symbols
- IV. Discuss Screen Setup Procedures
  - A. Discuss procedure for setting the screen color including the command line area and drawing area
  - B. Discuss the procedure for setting the properties of the cursor/crosshair
    - 1. Discuss the procedure for setting the size of the cursor/crosshair
    - 2. Discuss the procedure for selecting the style of cursor/crosshair
    - 3. Discuss the procedure for setting the color of the cursor/crosshair
  - C. Discuss the procedure for locating the menu/toolbar on the screen
  - D. Discuss the procedure for locating and setting the properties of the command line
- V. Discuss the Procedure for Setting the Various File Locations Necessary for Cad to Operate Properly Including:

- A. Menu file locations
- B. Drawing file locations
- C. Support file locations
- D. Printer driver locations
- E. Other file locations

VI. Discuss the Procedure for Setting the Object Snap Features
VII. Discuss the Procedure for Setting the Print/Plot Functions of CAD
VIII. Discuss the Procedure for Setting the Text Style
IX. Discuss the Procedure for Setting the Primary Units for a CAD Drawing
- A. Discuss the type of units to use:
  - 1. Decimal (e.g., 15.30)
  - 2. Scientific (e.g., 1.530 E+10)
  - 3. Engineering (e.g., 15' 6")
  - 4. Architectural (e.g., 15'-6 1/2")
- B. Discuss the setting of the accuracy of the units:
  - 1. Number of decimal places
  - 2. Smallest fractional unit

X. Discuss the Procedure for Setting the Menu/Toolbar
- A. Discuss the procedure for selecting the specific menu to load
- B. Discuss the procedure for selecting the specific toolbars to load
- C. Discuss the procedure for setting the location of the menu and toolbars

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Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions; and,
b) Demonstrate skills necessary for achieving educational objectives.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F6) dealing with using geometric objects (e.g., lines, splines, circles, etc.).

CAD-F5-HO
Utilize Drawing Setup Procedures
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify drawing setup procedures; and,
b. Perform drawing setup.

Module Outline:

I. Discuss Creation of Standard Layers for Mechanical Drawings
    A. Each layer used for specific linetype:
        1. Visible lines
        2. Hidden lines
        3. Center lines
        4. Phantom lines
        5. Dimension lines
        6. Extension lines
        7. Border line
        8. Construction line
        9. Section line
        10. Text
        11. Other miscellaneous linetypes used during drafting
    B. Each layer color controls the width of line during printing
II. Discuss the Selection and Loading of the Linetypes Necessary for Mechanical Drawing
III. Discuss the Inclusion of Internal Blocks Which May Be Used for the Following Purposes:
    A. Borders (inch and metric sizes)
    B. Title strips of various sizes (inch and metric sizes)
    C. Revision blocks (corresponding to the various border sizes)
    D. Bills of material (corresponding to the various border sizes)
    E. Tolerance blocks (corresponding to the various border sizes)
    F. Special symbols such as
        1. Mechanical parts
        2. Electrical symbols
        3. Dimension symbols
        4. Welding symbols
        5. HVAC symbols
IV. Discuss Screen Setup Procedures

- A. Discuss procedure for setting the screen color including the command line area and drawing area
- B. Discuss the procedure for setting the properties of the cursor/crosshair
  - 1. Discuss the procedure for setting the size of the cursor/crosshair
  - 2. Discuss the procedure for selecting the style of cursor/crosshair
  - 3. Discuss the procedure for setting the color of the cursor/crosshair
- C. Discuss the procedure for locating the menu/toolbar on the screen
- D. Discuss the procedure for locating and setting the properties of the command line

V. Discuss the Procedure for Setting the Various File Locations Necessary for Cad to Operate Properly Including:
- A. Menu file locations
- B. Drawing file locations
- C. Support file locations
- D. Printer driver locations
- E. Other file locations

VI. Discuss the Procedure for Setting the Object Snap Features

VII. Discuss the Procedure for Setting the Print/Plot Functions of CAD

VIII. Discuss the Procedure for Setting the Text Style

IX. Discuss the Procedure for Setting the Primary Units for a CAD Drawing
- A. Discuss the type of units to use:
  - 1. Decimal (e.g., 15.30)
  - 2. Scientific (e.g., 1.530 E+10)
  - 3. Engineering (e.g., 15' 6")
  - 4. Architectural (e.g., 15'-6 1/2")
- B. Discuss the setting of the accuracy of the units:
  - 1. Number of decimal places
  - 2. Smallest fractional unit

X. Discuss the Procedure for Setting the Menu/Toolbar
- A. Discuss the procedure for selecting the specific menu to load
- B. Discuss the procedure for selecting the specific toolbars to load
- C. Discuss the procedure for setting the location of the menu and toolbars

CAD-F5-LE
Utilize Drawing Setup Procedures
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) Demonstrate skills necessary for achieving educational objectives.

CAD-F6

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F6

Subject: **Computer-Aided Drafting & Design** **Time: 14 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)

Objective(s):

Upon completion of this unit the student will be able to:

a. Construct objects;
b. Edit objects; and,
c. Manipulate objects.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F6-HO)
MASTER Laboratory Exercise (CAD-F6-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"

Introduction:

The geometric construction commands are the most basic commands used in any CAD program. These commands include those required to manipulate and edit the geometric objects. They must be completely mastered before moving on to create complex mechanical drawings.

Presentation Outline:

I. Discuss Input Methods Used with Geometric Construction Commands
  A. Discuss use of coordinate points to locate geometry in two-dimensional space
    1. Use rectangular (Cartesian) coordinate points – (X,Y)
      a. Use absolute coordinate values – relative to origin (0,0)
      b. Use relative coordinate values – coordinate values relative to previous coordinate pair
    2. Use polar coordinate points – (R, θ)
      a. Use absolute coordinate values – relative to origin (0,0)
      b. Use relative coordinate values – coordinate values relative to previous coordinate pair
  B. Discuss procedure for using input devices
    1. Demonstrate "picking" method – using input device to specify coordinate points in the drawing area on the screen
      a. Use mouse button to pick coordinate values on the screen
      b. Use keyboard to type the coordinate values
    2. Demonstrate "entry" method – using input device to enter the command and have the computer generate the required geometry in the drawing area on the screen
      a. Use mouse button
      b. Use keyboard button
    3. Demonstrate "exit" method – method used to "exit" the command before proceeding to the next command
  C. Discuss method for selecting a command
    1. Demonstrate the procedure for picking the command from the menu area
    2. Demonstrate the procedure for typing the command
    3. Demonstrate the procedure for picking the command from the toolbar
II. Discuss Geometric Construction Commands
  A. Demonstrate the procedure for using the POINT construction command (or its equivalent)
  B. Demonstrate the procedure for using the LINE construction command (or its equivalent)
  C. Demonstrate the procedure for using the CIRCLE construction commands (or their equivalent)
  D. Demonstrate the procedure for using the ELLIPSE construction commands (or their equivalent)
  E. Demonstrate the procedure for using the ARC construction commands (or their equivalent)

F. Demonstrate the procedure for using the SPLINE construction command (or its equivalent)
G. Demonstrate the procedure for using the POLYLINE construction command (or its equivalent)
H. Demonstrate the procedure for using the POLYGON construction command (or its equivalent)

III. Discuss Commands Used to Edit Geometric Objects
  A. Demonstrate the procedure for selecting objects (creating a selection set)
    1. Picking objects with mouse
    2. Picking objects with keyboard commands
      a. Last object
      b. All objects
    3. Picking objects with a window
      a. Window
      b. Crossing window
  B. Demonstrate the procedure for removing objects from the selection set
  C. Demonstrate the procedure for using the ERASE command (or its equivalent)
  D. Demonstrate the procedure for using the TRIM command (or its equivalent)
  E. Demonstrate the procedure for using the EXTEND command (or its equivalent)
  F. Demonstrate the procedure for using the BREAK command (or its equivalent)

IV. Discuss Commands Used to Manipulate Geometric Objects
  A. Demonstrate the procedure for using the COPY command (or its equivalent)
  B. Demonstrate the procedure for using the MOVE command (or its equivalent)
  C. Demonstrate the procedure for using the SCALE command (or its equivalent)
  D. Demonstrate the procedure for using the OFFSET command (or its equivalent)
  E. Demonstrate the procedure for using the ROTATE command (or its equivalent)
  F. Demonstrate the procedure for using the MIRROR command (or its equivalent)
  G. Demonstrate the procedure for using the ARRAY command (or its equivalent)
  H. Demonstrate the procedure for using the LENGTHEN command (or its equivalent)

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings incorporating all discussed commands. The complexity of the drawing should increase progressively, beginning with the most basic drawing which incorporates the most basic geometric construction and editing commands.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F7) dealing with using text for drawing annotation.

CAD-F6-HO
Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Construct objects;
b. Edit objects; and,
c. Manipulate objects.

Module Outline:

I. Discuss Input Methods Used with Geometric Construction Commands
  A. Discuss use of coordinate points to locate geometry in two-dimensional space
    1. Use rectangular (Cartesian) coordinate points – (X,Y)
      a. Use absolute coordinate values – relative to origin (0,0)
      b. Use relative coordinate values – coordinate values relative to previous coordinate pair
    2. Use polar coordinate points – (R, θ)
      a. Use absolute coordinate values – relative to origin (0,0)
      b. Use relative coordinate values – coordinate values relative to previous coordinate pair
  B. Discuss procedure for using input devices
    1. Demonstrate “picking” method – using input device to specify coordinate points in the drawing area on the screen
      a. Use mouse button to pick coordinate values on the screen
      b. Use keyboard to type the coordinate values
    2. Demonstrate “entry” method – using input device to enter the command and have the computer generate the required geometry in the drawing area on the screen
      a. Use mouse button
      b. Use keyboard button
    3. Demonstrate “exit” method – method used to “exit” the command before proceeding to the next command
  C. Discuss method for selecting a command
    1. Demonstrate the procedure for picking the command from the menu area
    2. Demonstrate the procedure for typing the command
    3. Demonstrate the procedure for picking the command from the toolbar

II. Discuss Geometric Construction Commands

A. Demonstrate the procedure for using the POINT construction command (or its equivalent)
B. Demonstrate the procedure for using the LINE construction command (or its equivalent)
C. Demonstrate the procedure for using the CIRCLE construction commands (or their equivalent)
D. Demonstrate the procedure for using the ELLIPSE construction commands (or their equivalent)
E. Demonstrate the procedure for using the ARC construction commands (or their equivalent)
F. Demonstrate the procedure for using the SPLINE construction command (or its equivalent)
G. Demonstrate the procedure for using the POLYLINE construction command (or its equivalent)
H. Demonstrate the procedure for using the POLYGON construction command (or its equivalent)

III. Discuss Commands Used to Edit Geometric Objects
A. Demonstrate the procedure for selecting objects (creating a selection set)
  1. Picking objects with mouse
  2. Picking objects with keyboard commands
    a. Last object
    b. All objects
  3. Picking objects with a window
    a. Window
    b. Crossing window
B. Demonstrate the procedure for removing objects from the selection set
C. Demonstrate the procedure for using the ERASE command (or its equivalent)
D. Demonstrate the procedure for using the TRIM command (or its equivalent)
E. Demonstrate the procedure for using the EXTEND command (or its equivalent)
F. Demonstrate the procedure for using the BREAK command (or its equivalent)

IV. Discuss Commands Used to Manipulate Geometric Objects
A. Demonstrate the procedure for using the COPY command (or its equivalent)
B. Demonstrate the procedure for using the MOVE command (or its equivalent)
C. Demonstrate the procedure for using the SCALE command (or its equivalent)
D. Demonstrate the procedure for using the OFFSET command (or its equivalent)

E. Demonstrate the procedure for using the ROTATE command (or its equivalent)

F. Demonstrate the procedure for using the MIRROR command (or its equivalent)

G. Demonstrate the procedure for using the ARRAY command (or its equivalent)

H. Demonstrate the procedure for using the LENGTHEN command (or its equivalent)

CAD-F6-LE

Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)

Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings incorporating all discussed commands. The complexity of the drawing should increase progressively, beginning with the most basic drawing which incorporates the most basic geometric construction and editing commands.

CAD-F7

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F7

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Text For Drawing Annotation

Objective(s):

Upon completion of this unit the student will be able to:

a. Create text annotation; and,
b. Edit text.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F7-HO)
MASTER Laboratory Exercise (CAD-F7-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"

Introduction:

Text is used throughout mechanical drawing: in the title blocks, dimensions, notes, etc. The proper application of text is crucial to properly completing a mechanical drawing.

Presentation Outline:

- I. Discuss Procedure for Executing the TEXT Command (or its Equivalent)
    - A. Demonstrate method for executing TEXT command from menu
    - B. Demonstrate method for executing TEXT command from toolbar
    - C. Demonstrate method for executing TEXT command by typing
- II. Discuss TEXT Command Options
    - A. Discuss text starting point specification: coordinate point
    - B. Discuss text alignment and justification:
        - 1. Justification: Align / Fit / Center / Middle / Right / TL / TC / TR / ML / MC / MR / BL / BC / BR
        - 2. Alignment: vertical, horizontal, rotated
- III. Discuss Commands Used to Edit Text:
    - A. DDEDIT command – allows the text string to be changed
    - B. MODIFY PROPERTIES (select text) – allows all of the text properties to be changed (text string, starting point, text style, justification, alignment, layer, color, linetype, etc.)
- IV. Discuss STYLE Command
    - A. The STYLE command allows the CAD operator to change the text font.
    - B. Standard style for mechanical drawings – Roman Simplex (romans)

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings which allows the student to create and modify text.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F8) dealing with using viewing/display commands.

CAD-F7-HO
Use Text for Drawing Annotation
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Create text annotation; and,
- b. Edit text.

Module Outline:

- I. Discuss Procedure for Executing the TEXT Command (or its Equivalent)
  - A. Demonstrate method for executing TEXT command from menu
  - B. Demonstrate method for executing TEXT command from toolbar
  - C. Demonstrate method for executing TEXT command by typing
- II. Discuss TEXT Command Options
  - A. Discuss text starting point specification: coordinate point
  - B. Discuss text alignment and justification:
    - 1. Justification: Align / Fit / Center / Middle / Right / TL / TC / TR / ML / MC / MR / BL / BC / BR
    - 2. Alignment: vertical, horizontal, rotated
- III. Discuss Commands Used to Edit Text:
  - A. DDEDIT command – allows the text string to be changed
  - B. MODIFY PROPERTIES (select text) – allows all of the text properties to be changed (text string, starting point, text style, justification, alignment, layer, color, linetype, etc.)
- IV. Discuss STYLE Command
  - A. The STYLE command allows the CAD operator to change the text font.
  - B. Standard style for mechanical drawings – Roman Simplex (romans)

CAD-F7-LE
Use Text for Drawing Annotation
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) Create drawings which allows the student to create and modify text.

CAD-F8

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F8

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Viewing/Display Commands

Objective(s):

Upon completion of this unit the student will be able to:
a. Demonstrate view commands;
b. Create multiple viewing windows; and,
c. Demonstrate 3D display procedures.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F8-HO)
MASTER Laboratory Exercise (CAD-F8-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"

Introduction:

Viewing commands are used to show the CAD drawings at different positions, magnifications, and viewing positions (in the case of 3D objects). As drawings get progressively more larger and more complex the proper use of view commands are essential to the drafter. Using the viewing commands wisely can save much time and aggravation.

Presentation Outline:

- I. Identify the Basic Viewing Commands: ZOOM and PAN
  - A. Discuss the ZOOM command
    - 1. Define what the ZOOM command does
    - 2. Discuss the command options (All/Center/Dynamic/Extents/Previous/Scale(X/XP)/Window/Real time)
    - 3. Demonstrate the procedure for using the ZOOM command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
  - B. Discuss the PAN command
    - 1. Define what the PAN command does
    - 2. Discuss the command options (Realtime/Point/Left/Right/Up/Down)
    - 3. Demonstrate the procedure for using the PAN command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
- II. Discuss TILED VIEWPORT (VIEWPORTS) Command
  - A. Discuss the use of TILED VIEWPORTS in Model Space
  - B. Demonstrate the procedure for applying multiple viewports to the drawing area
  - C. Demonstrate procedure for saving/restoring viewports
- III. Discuss 3D Viewing Commands
  - A. Discuss parameters for 3D viewing
    - 1. Discuss 3D coordinate system
      - a. User Coordinate System (UCS)
      - b. World Coordinate System (WCS)
    - 2. Discuss coordinate location of observer
    - 3. Discuss coordinate location of object to be viewed
  - B. Discuss limitations of 3D viewing
    - 1. Can only draw on X-Y plane (at Z=0) as defined by the WCS
    - 2. Difficulty/confusion in drawing in 3D
    - 3. Difficulty/confusion in viewing 3D objects
  - C. Demonstrate VPOINT command
    - 1. Demonstrate coordinate entry method
    - 2. Demonstrate preset viewing positions
    - 3. Demonstrate use of Viewing Tripod
  - D. Discuss use of TILED VIEWPORTS for 3D viewing
    - 1. Orthographic views

    a. Preset views
    b. Using VPOINT command to specify orthographic views
  2. Setup for simulated orthographic views: top, front, right-side, etc.

IV. Discuss Saving Views
  A. Demonstrate the VIEW command for saving views
  B. Demonstrate the VIEW command for retrieving views

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) The instructor should demonstrate the above commands on a variety of drawings. No assignments are to be given to specifically test whether the various view commands are being used properly by the students. However, when the students are working on more complex drawings in later assignments, they must be able to perform various viewing operations.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F9) dealing with controlling object properties (color, linetype, etc.).

CAD-F8-HO
Use Viewing/Display Commands
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Demonstrate view commands;
b. Create multiple viewing windows; and,
c. Demonstrate 3D display procedures.

Module Outline:

- I. Identify the Basic Viewing Commands: ZOOM and PAN
  - A. Discuss the ZOOM command
    - 1. Define what the ZOOM command does
    - 2. Discuss the command options (All/Center/Dynamic/Extents/Previous/Scale(X/XP)/Window/Real time)
    - 3. Demonstrate the procedure for using the ZOOM command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
  - B. Discuss the PAN command
    - 1. Define what the PAN command does
    - 2. Discuss the command options (Realtime/Point/Left/Right/Up/Down)
    - 3. Demonstrate the procedure for using the PAN command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
- II. Discuss TILED VIEWPORT (VIEWPORTS) Command
  - A. Discuss the use of TILED VIEWPORTS in Model Space
  - B. Demonstrate the procedure for applying multiple viewports to the drawing area
  - C. Demonstrate procedure for saving/restoring viewports
- III. Discuss 3D Viewing Commands
  - A. Discuss parameters for 3D viewing
    - 1. Discuss 3D coordinate system
      - a. User Coordinate System (UCS)
      - b. World Coordinate System (WCS)
    - 2. Discuss coordinate location of observer
    - 3. Discuss coordinate location of object to be viewed
  - B. Discuss limitations of 3D viewing
    - 1. Can only draw on X-Y plane (at Z=0) as defined by the WCS
    - 2. Difficulty/confusion in drawing in 3D

    - 3. Difficulty/confusion in viewing 3D objects
  - C. Demonstrate VPOINT command
    - 1. Demonstrate coordinate entry method
    - 2. Demonstrate preset viewing positions
    - 3. Demonstrate use of Viewing Tripod
  - D. Discuss use of TILED VIEWPORTS for 3D viewing
    - 1. Orthographic views
      - a. Preset views
      - b. Using VPOINT command to specify orthographic views
    - 2. Setup for simulated orthographic views: top, front, right-side, etc.
- IV. Discuss Saving Views
  - A. Demonstrate the VIEW command for saving views
  - B. Demonstrate the VIEW command for retrieving views

CAD-F8-LE
Use Viewing/Display Commands
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) The instructor should demonstrate the above commands on a variety of drawings. No assignments are to be given to specifically test whether the various view commands are being used properly by the students. However, when the students are working on more complex drawings in later assignments, they must be able to perform various viewing operations.

CAD-F9

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F9

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Control Object Properties

Objective(s):

Upon completion of this unit the student will be able to:

a. Determine object property; and,
b. Modify object property.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F9-HO)
MASTER Laboratory Exercise (CAD-F9-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"

Introduction:

Drawing objects, such as lines, circles, and text, are displayed according to their property specifications. These specifications control, among other things, the color,

linetype and specific geometry of the drawing objects. It is often necessary to view and/or modify these properties and the CAD drafter must be well-versed in this skill.

Presentation Outline:

I. Discuss Object Properties
    A. Define object property: visual and geometric of a graphical object (line, circle, text).
    B. Discuss general properties:
        1. Color
        2. Layer
        3. Linetype
    C. Discuss object-specific properties:
        1. Geometric data (e.g., starting point, ending point, radius, etc.)
        2. Style (e.g., text style, dimension style, etc.)
        3. Miscellaneous (linetype scale, block, insertion point, etc.)

II. Discuss Procedure for Displaying Object Properties
    A. Demonstrate the use of the Modify Properties command
    B. Demonstrate the use of the LIST command

III. Discuss Procedure for Modifying Object Properties
    A. Demonstrate the use of the Modify Properties command
    B. Discuss special property modifying commands (modify text, modify hatch, modify dimension, modify polyline, modify spline, modify multiline)
    C. Demonstrate the procedure for using the Match Properties command

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Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings using various drawing objects (lines, circle, text, etc.). Students must then modify the properties of the objects according to given specifications.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F10) dealing with understanding procedure to print/plot a drawing.

CAD-F9-HO
Control Object Properties
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Determine object property; and,
b. Modify object property.

Module Outline:

- I. Discuss Object Properties
  - A. Define object property: visual and geometric of a graphical object (line, circle, text).
  - B. Discuss general properties:
    - 1. Color
    - 2. Layer
    - 3. Linetype
  - C. Discuss object-specific properties:
    - 1. Geometric data (e.g., starting point, ending point, radius, etc.)
    - 2. Style (e.g., text style, dimension style, etc.)
    - 3. Miscellaneous (linetype scale, block, insertion point, etc.)
- II. Discuss Procedure for Displaying Object Properties
  - A. Demonstrate the use of the Modify Properties command
  - B. Demonstrate the use of the LIST command
- III. Discuss Procedure for Modifying Object Properties
  - A. Demonstrate the use of the Modify Properties command
  - B. Discuss special property modifying commands (modify text, modify hatch, modify dimension, modify polyline, modify spline, modify multiline)
  - C. Demonstrate the procedure for using the Match Properties command

CAD-F9-LE
Control Object Properties
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings using various drawing objects (lines, circle, text, etc.). Students must then modify the properties of the objects according to given specifications.

CAD-F10

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F10

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Understand Procedure to Print/Plot a Drawing

Objective(s):

Upon completion of this unit the student will be able to:
a. Demonstrate plotting procedure;
b. Determine scaling and layout; and,
c. Use various printers and plotters.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F10-HO)
MASTER Laboratory Exercise (CAD-F10-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"

Introduction:

CAD drawings are printed at various scales to accommodate the relative size of the drawn object and the paper size. In addition, proper printed line thickness is critical to the proper appearance of the final product.

Presentation Outline:

I. Discuss Important Printing Factors
  A. Define drawing scale: the resultant scale at which the drawing is printed. CAD drawings are always drawn at full scale; they are scaled up or down at the printing stage.
  B. Discuss how to control the thickness of the plotted lines
    1. The thickness of the plotted lines is controlled by the color of the lines as they appear in the CAD drawing.
    2. The color of the lines in the CAD drawing is typically controlled by the layer on which the drawing object resides (e.g., the VISIBLE layer is yellow, therefore all the lines drawn on that layer are yellow and they will plot with the thickness that is assigned to the color yellow.)
    3. The pen thickness setting is used to specify the width of the plotted lines
  C. Discuss how to select the plotted paper size
    1. Directly related to the plotted drawing scale and the size of the drawing
    2. Use standard drawing sheet sizes (see CAD-B1: Use Drawing Media and Related Drafting Materials)

II. Discuss the Procedure for Printing a Drawing
  A. Demonstrate the procedure for selecting the PRINT command
  B. Discuss the features of the Print Dialog Box
    1. ***Device selection:*** demonstrate the procedure for selecting a printer or plotter
    2. ***Pen parameters:*** demonstrate the procedure for assigning a pen to a color and specifying the width of the pen
    3. Demonstrate the procedure for specifying the type of view to be plotted
      a. Extents: plot all drawing objects
      b. Window: specify a rectangular window which will define the plotting area
      c. Display: plot the drawing as shown in the current drawing view
      d. Limits: the area to plot is specified by the prescribed limits of the drawing, set with the LIMITS command.

4. *Paper size:* demonstrate the procedure for selecting the desired paper size measured in appropriate units (inches or millimeters)
5. Demonstrate the procedure for specifying the desired plotting scale and orientation
    a. Specify the plotted scale according to the formula [plotted units] = [drawing units] (e.g., 1=2 scale (half scale) corresponds to 1 inch measured on the plotted drawing is equal to 2 inches measured in the CAD drawing)
    b. Specify the plot rotation: how the plotted drawing will be rotate on the paper
    c. Specify the origin of the plot: specify the location of the origin (0,0) in the CAD drawing on the plotted drawing.
6. Demonstrate the procedure for viewing a plot preview
7. Demonstrate the procedure for plotting to a file

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Plot various drawings using given plot settings, such as plot scale, viewing area, paper size, etc.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F11) dealing with using standard layering techniques.

CAD-F10-HO
Understand Procedure to Print/Plot a Drawing
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Demonstrate plotting procedure;
- b. Determine scaling and layout; and,
- c. Use various printers and plotters.

Module Outline:

- I. Discuss Important Printing Factors
  - A. Define drawing scale: the resultant scale at which the drawing is printed. CAD drawings are always drawn at full scale; they are scaled up or down at the printing stage.
  - B. Discuss how to control the thickness of the plotted lines
    - 1. The thickness of the plotted lines is controlled by the color of the lines as they appear in the CAD drawing.
    - 2. The color of the lines in the CAD drawing is typically controlled by the layer on which the drawing object resides (e.g., the VISIBLE layer is yellow, therefore all the lines drawn on that layer are yellow and they will plot with the thickness that is assigned to the color yellow.)
    - 3. The pen thickness setting is used to specify the width of the plotted lines
  - C. Discuss how to select the plotted paper size
    - 1. Directly related to the plotted drawing scale and the size of the drawing
    - 2. Use standard drawing sheet sizes (see CAD-B1: Use Drawing Media and Related Drafting Materials)
- II. Discuss the Procedure for Printing a Drawing
  - A. Demonstrate the procedure for selecting the PRINT command
  - B. Discuss the features of the Print Dialog Box
    - 1. ***Device selection:*** demonstrate the procedure for selecting a printer or plotter
    - 2. ***Pen parameters:*** demonstrate the procedure for assigning a pen to a color and specifying the width of the pen
    - 3. Demonstrate the procedure for specifying the type of view to be plotted
      - a. Extents: plot all drawing objects
      - b. Window: specify a rectangular window which will define the plotting area

    c. Display: plot the drawing as shown in the current drawing view
    d. Limits: the area to plot is specified by the prescribed limits of the drawing, set with the LIMITS command.
4. *Paper size:* demonstrate the procedure for selecting the desired paper size measured in appropriate units (inches or millimeters)
5. Demonstrate the procedure for specifying the desired plotting scale and orientation
    a. Specify the plotted scale according to the formula [plotted units] = [drawing units] (e.g., 1=2 scale (half scale) corresponds to 1 inch measured on the plotted drawing is equal to 2 inches measured in the CAD drawing)
    b. Specify the plot rotation: how the plotted drawing will be rotate on the paper
    c. Specify the origin of the plot: specify the location of the origin (0,0) in the CAD drawing on the plotted drawing.
6. Demonstrate the procedure for viewing a plot preview
7. Demonstrate the procedure for plotting to a file

CAD-F10-LE
Understand Procedure to Print/Plot a Drawing
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Plot various drawings using given plot settings, such as plot scale, viewing area, paper size, etc.

CAD-F11

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F11

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Standard Layering Techniques

Objective(s):

Upon completion of this unit the student will be able to:
a. Define standard layering procedures; and,
b. Apply standard layering techniques.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F11-HO)
MASTER Laboratory Exercise (CAD-F11-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"
CAD-F10	"Understand Procedure to Print/Plot a Drawing"

Introduction:

CAD drawings are printed at various scales to accommodate the relative size of the drawn object and the paper size. In addition, proper printed line thickness is critical to the proper appearance of the final product.

Presentation Outline:

- I. Define Layers: Named Groups of Graphical Objects Which Can Be Set to Have the Same Color and Linetype Property
  - A. Layers can be turned on or off in order to show or hide the objects on that layer
  - B. The color and linetype properties of the objects on a layer can be modified with a single command
  - C. The current layer is the layer that newly created objects will be placed on
- II. Discuss Standard Usage of Layers in CAD
  - A. Objects typically grouped according to standard linetypes used in mechanical drafting
    - 1. All hidden lines are placed on the "Hidden" layer
    - 2. All visible lines (continuous lines) are placed on the "Visible" layer
    - 3. All center lines are placed on the "Center" layer
    - 4. All phantom lines are placed on the "Cutting-Plane" layer
  - B. Layer groups also include to special objects
    - 1. All section lines (continuous lines) are placed on the "Section" layer
    - 2. All dimension lines (continuous lines) are placed on the "Dimension" layer
    - 3. All text (continuous lines) is placed on the "Text" layer
    - 4. The title block and border is placed on the "Title-block" layer
  - C. Additional grouping for assembly drawings according to object type (e.g., all bolts are placed on the "Bolts" layer, all gears are placed on the "Gear" layer, etc.)
  - D. Layer names should correspond to some feature of the objects residing on the layer
  - E. Maintain same color/linetype specifications on layer (e.g., do not place red lines on the "Visible" layer set to the color yellow)
  - F. Additional objects or features that do not fall into a pre-made layer should be placed on a new layer
- III. Demonstrate the LAYER Command
  - A. Demonstrate the procedure for creating a new layer
  - B. Demonstrate the procedure for modifying an existing layer
    - 1. Changing the color

   2. Changing the linetype
C. Demonstrate the procedure for controlling the visibility of the layer
   1. Freeze or thaw the layer
   2. Turn on or off the layer
D. Demonstrate the procedure for changing the current layer

IV. Demonstrate Other Commands Associated with Layers
   A. Demonstrate the MATCH PROPERTIES command: change the properties (including the layer) of a selected set of objects to match the properties of another object
   B. Demonstrate the MODIFY PROPERTIES command: change the layer of a selected group of objects
   C. The BYLAYER property used as the color or linetype for an object specifies that that objects' color and linetype is set according to the layer on which it resides

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Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions;
b) Create drawings with multiple layers;
c) Change objects from one layer to another;
d) Change the properties of the layers;
e) Create new layers; and,
f) Use layers according to standard layer usage rules.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F12) dealing with creating mechanical CAD drawings.

CAD-F11-HO
Use Standard Layering Techniques
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Define standard layering procedures; and,

b. Apply standard layering techniques.

Module Outline:

I. Define Layers: Named Groups of Graphical Objects Which Can Be Set to Have the Same Color and Linetype Property
  A. Layers can be turned on or off in order to show or hide the objects on that layer
  B. The color and linetype properties of the objects on a layer can be modified with a single command
  C. The current layer is the layer that newly created objects will be placed on

II. Discuss Standard Usage of Layers in CAD
  A. Objects typically grouped according to standard linetypes used in mechanical drafting
    1. All hidden lines are placed on the "Hidden" layer
    2. All visible lines (continuous lines) are placed on the "Visible" layer
    3. All center lines are placed on the "Center" layer
    4. All phantom lines are placed on the "Cutting-Plane" layer
  B. Layer groups also include to special objects
    1. All section lines (continuous lines) are placed on the "Section" layer
    2. All dimension lines (continuous lines) are placed on the "Dimension" layer
    3. All text (continuous lines) is placed on the "Text" layer
    4. The title block and border is placed on the "Title-block" layer
  C. Additional grouping for assembly drawings according to object type (e.g., all bolts are placed on the "Bolts" layer, all gears are placed on the "Gear" layer, etc.)
  D. Layer names should correspond to some feature of the objects residing on the layer
  E. Maintain same color/linetype specifications on layer (e.g., do not place red lines on the "Visible" layer set to the color yellow)
  F. Additional objects or features that do not fall into a pre-made layer should be placed on a new layer

III. Demonstrate the LAYER Command
  A. Demonstrate the procedure for creating a new layer
  B. Demonstrate the procedure for modifying an existing layer
    1. Changing the color
    2. Changing the linetype
  C. Demonstrate the procedure for controlling the visibility of the layer
    1. Freeze or thaw the layer
    2. Turn on or off the layer
  D. Demonstrate the procedure for changing the current layer

IV. Demonstrate Other Commands Associated with Layers
  A. Demonstrate the MATCH PROPERTIES command: change the properties (including the layer) of a selected set of objects to match the properties of another object
  B. Demonstrate the MODIFY PROPERTIES command: change the layer of a selected group of objects
  C. The BYLAYER property used as the color or linetype for an object specifies that that objects' color and linetype is set according to the layer on which it resides

CAD-F11-LE
Use Standard Layering Techniques
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;
b) Create drawings with multiple layers;
c) Change objects from one layer to another;
d) Change the properties of the layers;
e) Create new layers; and,
f) Use layers according to standard layer usage rules.

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F12

Subject: **Computer-Aided Drafting & Design** **Time: 1 Hr.**

Duty: **Use Computer-Aided Drafting System**
Task: Create Mechanical CAD Drawings

Objective(s):

Upon completion of this unit the student will be able to:
a. Use CAD to create multi-view orthographic drawings; and,
b. Understand 2D multi-view drawing procedures on CAD system.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F12-HO)
MASTER Laboratory Exercise (CAD-F12-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.
Technical Drawing, Giesecke, F. E., et al., Prentice-Hall, Inc. Publishing, Latest Edition
Engineering Drawing and Design, Jensen, C. H., Helsel, J. D., Short, D., Glencoe/McGraw-Hill Publishing, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"

CAD-F10 "Understand Procedure to Print/Plot a Drawing"
CAD-F11 "Use Standard Layering Techniques"

Introduction:

Creating mechanical drawings using CAD incorporates many of the basic CAD drawing procedures with mechanical drafting guidelines and rules. Proper use of orthographic projection is critical at this point, as well as the ability to properly layout the drawing inside to title block and border.

Presentation Outline:

- I. Discuss Orthographic Projection in CAD
  - A. Demonstrate procedure for maintaining alignment between views
    - 1. Use line projected horizontally or vertically to line-up adjacent views
    - 2. Extend boundary edges of object in one view to adjacent views
    - 3. Construct miter line for adjacent views that do not share a fold line (e.g., top and right-side view)
  - B. Demonstrate procedure for creating a new orthographic view from an existing orthographic view
    - 1. Demonstrate procedure for creating a regular orthographic view
      - a. Project/draw lines from existing views perpendicularly through fold line
      - b. Establish reference plane/surface
        - (1) Use fold line as reference plane/surface
        - (2) Use OFFSET command to create reference plane/surface
        - (3) Use coordinate drawing to create reference plane/surface
      - c. Begin drawing new view using measurements based on reference plane/surface
        - (1) Use OFFSET command to create lines from reference plane/surface
        - (2) Use coordinate entry to create lines from reference plane/surface
    - 2. Demonstrate procedure for creating an auxiliary view
      - a. Draw auxiliary fold line parallel to inclined surface (surface to be projected in the auxiliary view)
        - (1) Use COPY command to create parallel copy of inclined surface
        - (2) Use OFFSET command to create parallel copy of inclined surface
      - b. Project lines perpendicularly through auxiliary fold line

            - (1) Use EXTEND command to project line to fold line
            - (2) Draw lines using PERPENDICULAR OBJECT SNAP and "snapping" perpendicular to fold line
        - c. Establish reference plane/surface
            - (1) Use fold line as reference plane/surface
            - (2) Use OFFSET command to create reference plane/surface
            - (3) Use coordinate drawing to create reference plane/surface
        - d. Begin drawing new view using measurements based on reference plane/surface
            - (1) Use OFFSET command to create lines from reference plane/surface
            - (2) Use coordinate entry to create lines from reference plane/surface

- II. Discuss Drawing Layout in CAD
    - A. Demonstrate procedure for drawing title block and border
        - 1. Determine sufficient paper size for drawing (use ANSI or ISO standard sizes)
            - a. Use ANSI inch sizes for drawings in inches
            - b. Use ISO millimeter sizes for metric drawings (drawn in millimeters)
        - 2. Draw rectangular border one inch inset from paper border on all sides (e.g., if paper size is 17"x11" then border size is 15"x9")
        - 3. Determine title block layout (see mechanical drawing textbook for acceptable sizes, shapes, and layouts)
    - B. Demonstrate procedure for centering the drawing within the border
        - 1. Set distances between views
            - a. Allow for dimensions if applicable
            - b. Allow for labels if applicable
        - 2. Determine maximum distances in each view (distances parallel to border edges)
            - a. Maximum length and height in front and back views
            - b. Maximum height and width in side views
            - c. Maximum width and length in top and bottom views
            - d. Determine maximum dimensions, measured parallel to border edges, of auxiliary views
        - 3. Determine usable area in border (allow for title block and notes)
        - 4. Compute distance from edge of border to edge of views using distances determined above
        - 5. Adjust layout of views to accommodate discrepancies or irregularities

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create mechanical drawings. Drawings should progress through difficulty from relatively simple geometry to more complex geometry.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F13) dealing with creating 3D mechanical models.

CAD-F12-HO
Create Mechanical CAD Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Use CAD to create multi-view orthographic drawings; and,
- b. Understand 2D multi-view drawing procedures on CAD system.

Module Outline:

- I. Discuss Orthographic Projection in CAD
  - A. Demonstrate procedure for maintaining alignment between views
    - 1. Use line projected horizontally or vertically to line-up adjacent views
    - 2. Extend boundary edges of object in one view to adjacent views
    - 3. Construct miter line for adjacent views that do not share a fold line (e.g., top and right-side view)
  - B. Demonstrate procedure for creating a new orthographic view from an existing orthographic view
    - 1. Demonstrate procedure for creating a regular orthographic view
      - a. Project/draw lines from existing views perpendicularly through fold line
      - b. Establish reference plane/surface
        - (1) Use fold line as reference plane/surface
        - (2) Use OFFSET command to create reference plane/surface
        - (3) Use coordinate drawing to create reference plane/surface
      - c. Begin drawing new view using measurements based on reference plane/surface
        - (1) Use OFFSET command to create lines from reference plane/surface
        - (2) Use coordinate entry to create lines from reference plane/surface
    - 2. Demonstrate procedure for creating an auxiliary view
      - a. Draw auxiliary fold line parallel to inclined surface (surface to be projected in the auxiliary view)
        - (1) Use COPY command to create parallel copy of inclined surface
        - (2) Use OFFSET command to create parallel copy of inclined surface
      - b. Project lines perpendicularly through auxiliary fold line

      - (1) Use EXTEND command to project line to fold line
      - (2) Draw lines using PERPENDICULAR OBJECT SNAP and "snapping" perpendicular to fold line
    - c. Establish reference plane/surface
      - (1) Use fold line as reference plane/surface
      - (2) Use OFFSET command to create reference plane/surface
      - (3) Use coordinate drawing to create reference plane/surface
    - d. Begin drawing new view using measurements based on reference plane/surface
      - (1) Use OFFSET command to create lines from reference plane/surface
      - (2) Use coordinate entry to create lines from reference plane/surface

- II. Discuss Drawing Layout in CAD
  - A. Demonstrate procedure for drawing title block and border
    - 1. Determine sufficient paper size for drawing (use ANSI or ISO standard sizes)
      - a. Use ANSI inch sizes for drawings in inches
      - b. Use ISO millimeter sizes for metric drawings (drawn in millimeters)
    - 2. Draw rectangular border one inch inset from paper border on all sides (e.g., if paper size is 17"x11" then border size is 15"x9")
    - 3. Determine title block layout (see mechanical drawing textbook for acceptable sizes, shapes, and layouts)
  - B. Demonstrate procedure for centering the drawing within the border
    - 1. Set distances between views
      - a. Allow for dimensions if applicable
      - b. Allow for labels if applicable
    - 2. Determine maximum distances in each view (distances parallel to border edges)
      - a. Maximum length and height in front and back views
      - b. Maximum height and width in side views
      - c. Maximum width and length in top and bottom views
      - d. Determine maximum dimensions, measured parallel to border edges, of auxiliary views
    - 3. Determine usable area in border (allow for title block and notes)
    - 4. Compute distance from edge of border to edge of views using distances determined above
    - 5. Adjust layout of views to accommodate discrepancies or irregularities

CAD-F12-LE
Create Mechanical CAD Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create mechanical drawings. Drawings should progress through difficulty from relatively simple geometry to more complex geometry.

CAD-F13

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F13

Subject: **Computer-Aided Drafting & Design** **Time: 10 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Create 3D Mechanical Models

Objective(s):

Upon completion of this unit the student will be able to:
a. Convert 2D drawing information into 3D;
b. Create and edit wireframe model;
c. Create and edit 3D surface model; and,
d. Create and edit 3D solid model.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F13-HO)
MASTER Laboratory Exercise (CAD-F13-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"
CAD-F10	"Understand Procedure to Print/Plot a Drawing"
CAD-F11	"Use Standard Layering Techniques"

CAD-F12 "Create Mechanical CAD Drawings"

Introduction:

Personal computers today are faster, more powerful, and cheaper than they have ever been. Because of this, more mechanical design is being done with 3D models. There are three types of 3D models which can be created: wireframe, surface model, and solid model.

Presentation Outline:

I. Discuss Dimensions (2D) in Orthographic Projection
  A. Discuss the dimensions in each orthographic view (standard views)
    1. Demonstrate how front and back views show height and length dimensions
    2. Demonstrate how top and bottom views show length and width dimensions
    3. Demonstrate how side views show width and height dimensions
  B. Discuss the duplication of dimensions between views
    1. Demonstrate the "common measurement rule"

II. Discuss Applying Dimensions from Orthographic Views to 3D Models
  A. Determine how dimensions correlate to 3D axis (X, Y, Z)
    1. Width dimensions parallel to Y axis
    2. Length dimensions parallel to X axis
    3. Height dimensions parallel to Z axis
  B. Discuss orientation of 3D coordinate axis
    1. Z axis is normal to computer screen in "2D" drawings, the X-axis is horizontal and positive to the right, and the Y-axis is vertical and positive upwards
    2. In 3D drawings, the height dimensions are in the positive direction of the Z axis
    3. Use "right-hand rule" for orienting 3D axis in space

III. Discuss 3D Viewing Techniques
  A. Discuss setting multiple views in the drawing area
    1. Demonstrate the procedure for setting an orthographic view (top, front, side view)
    2. Demonstrate the procedure for setting an isometric view
  B. Demonstrate the procedure for using a selected view to aid in reorienting the UCS

IV. Discuss 3D Line Drawing in CAD
  A. Discuss the 2D drawing plane
    1. CAD only allows drawing parallel to the X-Y plane of the User Coordinate System (UCS) at the current elevation (Z value)

            - a. Discuss how the World Coordinate System (WCS) cannot be modified
            - b. Demonstrate how to use the UCS command to manipulate the User Coordinate System to reorient the X-Y plane to the proper plane for drawing
        - 2. Demonstrate how to use the ELEVATION command to change the Z value
        - 3. Discuss special cases:
            - a. Point-to-point drawing can be done no matter the orientation of the X-Y plane
            - b. 2D shapes (circles, polygons, etc.) are always oriented parallel to the X-Y plane
    - B. Discuss 3D wireframe drawing
        - 1. Define *wireframe:* a 3D drawing using only 1D objects, such as lines and circles. A drawing of an object constructed of "wires".
        - 2. Demonstrate the procedure for creating 3D wireframe drawing
            - a. Use UCS command to change UCS to reorient the X-Y plane
            - b. Use COPY command to quickly draw repetitive features
            - c. Use OBJECT SNAP to "snap" to geometric points on the objects
        - 3. Demonstrate the procedure for setting 3D views of wireframe object
            - a. Use multiple viewports to view object from different vantage points
            - b. Set multiple viewports as orthographic views
- V. Discuss Surface Modeling in CAD
    - A. Define surface: a 2D shape lacking thickness, typically planar although special non-planar shapes can be constructed
    - B. Define surface model: a 3D object made up of 2D surfaces and lacking a solid volume (hollow)
    - C. Discuss surface modeling commands:
        - 1. Demonstrate the procedure for creating a 3D face
        - 2. Demonstrate the procedure for creating a revolved surface
        - 3. Demonstrate the procedure for creating a tabulated (mesh) surface
        - 4. Demonstrate the procedure for creating a ruled surface
        - 5. Demonstrate the procedure for creating an edge surface
    - D. Demonstrate the procedure for creating a surface model
        - 1. Use UCS command to reorient the X-Y plane
        - 2. Use wireframe model/lines for locating surfaces endpoints
        - 3. Use 3D edit commands to modify surface model
            - a. Demonstrate 3D rotate command
            - b. Demonstrate 3D mirror command

c. Demonstrate 3D array command
VI. Discuss Solid Modeling in CAD
A. Define solid model: a 3D object with a solid volume
B. Discuss techniques used to create and edit solid models
1. Define Boolean construction: construction of 3D solid shapes from two separate solid objects using logical operations, such as UNION, SUBTRACT, INTERSECT
2. Define Primitive: one of six basic 3D solid shapes (sphere, box, cylinder, torus, wedge, cone, pyramid)
3. Demonstrate the procedure for creating a 3D solid primitive
a. Demonstrate the procedure for using the
4. Demonstrate the procedure for orienting a 3D solid object 3D space
a. Use the MOVE command
b. Use the COPY command
c. Use the 3D rotate command
d. Use the 3D mirror command
e. Use the 3D array command
5. Demonstrate the procedure for using Boolean operations
a. Demonstrate the UNION command
b. Demonstrate the SUBTRACT command
c. Demonstrate the INTERSECT command

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions;
b) Create 3D wireframe models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry;
c) Create 3D surface models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry; and,
d) Create 3D solid models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F14) dealing with utilizing CAD drawing data.

CAD-F13-HO
Create 3D Mechanical Models
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Convert 2D drawing information into 3D;
b. Create and edit wireframe model;
c. Create and edit 3D surface model; and,
d. Create and edit 3D solid model.

Module Outline:

I. Discuss Dimensions (2D) in Orthographic Projection
  A. Discuss the dimensions in each orthographic view (standard views)
    1. Demonstrate how front and back views show height and length dimensions
    2. Demonstrate how top and bottom views show length and width dimensions
    3. Demonstrate how side views show width and height dimensions
  B. Discuss the duplication of dimensions between views
    1. Demonstrate the "common measurement rule"
II. Discuss Applying Dimensions from Orthographic Views to 3D Models
  A. Determine how dimensions correlate to 3D axis (X, Y, Z)
    1. Width dimensions parallel to Y axis
    2. Length dimensions parallel to X axis
    3. Height dimensions parallel to Z axis
  B. Discuss orientation of 3D coordinate axis
    1. Z axis is normal to computer screen in "2D" drawings, the X-axis is horizontal and positive to the right, and the Y-axis is vertical and positive upwards
    2. In 3D drawings, the height dimensions are in the positive direction of the Z axis
    3. Use "right-hand rule" for orienting 3D axis in space
III. Discuss 3D Viewing Techniques
  A. Discuss setting multiple views in the drawing area
    1. Demonstrate the procedure for setting an orthographic view (top, front, side view)
    2. Demonstrate the procedure for setting an isometric view
  B. Demonstrate the procedure for using a selected view to aid in reorienting the UCS
IV. Discuss 3D Line Drawing in CAD
  A. Discuss the 2D drawing plane

1. CAD only allows drawing parallel to the X-Y plane of the User Coordinate System (UCS) at the current elevation (Z value)
   a. Discuss how the World Coordinate System (WCS) cannot be modified
   b. Demonstrate how to use the UCS command to manipulate the User Coordinate System to reorient the X-Y plane to the proper plane for drawing
2. Demonstrate how to use the ELEVATION command to change the Z value
3. Discuss special cases:
   a. Point-to-point drawing can be done no matter the orientation of the X-Y plane
   b. 2D shapes (circles, polygons, etc.) are always oriented parallel to the X-Y plane

B. Discuss 3D wireframe drawing
1. Define *wireframe:* a 3D drawing using only 1D objects, such as lines and circles. A drawing of an object constructed of "wires".
2. Demonstrate the procedure for creating 3D wireframe drawing
   a. Use UCS command to change UCS to reorient the X-Y plane
   b. Use COPY command to quickly draw repetitive features
   c. Use OBJECT SNAP to "snap" to geometric points on the objects
3. Demonstrate the procedure for setting 3D views of wireframe object
   a. Use multiple viewports to view object from different vantage points
   b. Set multiple viewports as orthographic views

V. Discuss Surface Modeling in CAD

A. Define surface: a 2D shape lacking thickness, typically planar although special non-planar shapes can be constructed

B. Define surface model: a 3D object made up of 2D surfaces and lacking a solid volume (hollow)

C. Discuss surface modeling commands:
1. Demonstrate the procedure for creating a 3D face
2. Demonstrate the procedure for creating a revolved surface
3. Demonstrate the procedure for creating a tabulated (mesh) surface
4. Demonstrate the procedure for creating a ruled surface
5. Demonstrate the procedure for creating an edge surface

D. Demonstrate the procedure for creating a surface model
1. Use UCS command to reorient the X-Y plane
2. Use wireframe model/lines for locating surfaces endpoints
3. Use 3D edit commands to modify surface model

        - a. Demonstrate 3D rotate command
        - b. Demonstrate 3D mirror command
        - c. Demonstrate 3D array command

VI. Discuss Solid Modeling in CAD

- A. Define solid model: a 3D object with a solid volume
- B. Discuss techniques used to create and edit solid models
    1. Define Boolean construction: construction of 3D solid shapes from two separate solid objects using logical operations, such as UNION, SUBTRACT, INTERSECT
    2. Define Primitive: one of six basic 3D solid shapes (sphere, box, cylinder, torus, wedge, cone, pyramid)
    3. Demonstrate the procedure for creating a 3D solid primitive
        - a. Demonstrate the procedure for using the
    4. Demonstrate the procedure for orienting a 3D solid object 3D space
        - a. Use the MOVE command
        - b. Use the COPY command
        - c. Use the 3D rotate command
        - d. Use the 3D mirror command
        - e. Use the 3D array command
    5. Demonstrate the procedure for using Boolean operations
        - a. Demonstrate the UNION command
        - b. Demonstrate the SUBTRACT command
        - c. Demonstrate the INTERSECT command

CAD-F13-LE
Create 3D Mechanical Models
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create 3D wireframe models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry;

c) Create 3D surface models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry; and,

d) Create 3D solid models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry.

CAD-F14

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F14

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Use Drawing Feature Attributes

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify attribute data;
b. Apply attribute data; and,
c. Extract attribute data.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F14-HO)
MASTER Laboratory Exercise (CAD-F14-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"
CAD-F10	"Understand Procedure to Print/Plot a Drawing"
CAD-F11	"Use Standard Layering Techniques"
CAD-F12	"Create Mechanical CAD Drawings"

CAD-F13 "Create 3D Mechanical Models"

Introduction:

Attributes can be used for many advanced functions in CAD. Many of these functions will help to streamline the design process and even help in other areas such as accounting and administration.

Presentation Outline:

I. Define and Discuss Attributes
  A. Definition: an attribute is an interactive label attached to a block of drawing objects
  B. Discuss uses for attributes
    1. Parts list
    2. Bill of materials
    3. Price list
  C. Discuss requirements for use of attributes
    1. Object must be a block
    2. Define attributes for the block
    3. Text file reader for post-processing of extracted attribute data

II. Discuss Creation of Attributes
  A. Demonstrate the procedure for creating attribute definition (DDATTDEF command)
    1. Describe tag
    2. Describe prompt
    3. Describe value information
    4. Describe text formatting
    5. Describe location
    6. Describe optional definitions
  B. Demonstrate the procedure for associating attribute with block definition
  C. Demonstrate procedure for inserting block into drawing
  D. Demonstrate the procedure for entering attribute data for specific block

III. Discuss Extracting Data from an Attribute in a Drawing
  A. Demonstrate the procedure for using the ATTEXT command
  B. Discuss file format
    1. Comma Delimited File (CDF)
    2. Space Delimited File (SDF)
    3. Drawing Interchange File (DXF)
  C. Discuss using a template file for extracting the data
  D. Demonstrate the procedure for opening a text processing program (e.g., WORDPAD or NOTEPAD)

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Perform attribute operations on a drawing, including:
   (1) Defining the attributes;
   (2) Inserting the attributes;
   (3) Extracting the attribute information; and,
   (4) Performing a post analysis on the extracted attribute information.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F15) dealing with obtaining 3D model property data.

CAD-F14-HO
Use Drawing Feature Attributes
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify attribute data;

b. Apply attribute data; and,

c. Extract attribute data.

Module Outline:

I. Define and Discuss Attributes
  - A. Definition: an attribute is an interactive label attached to a block of drawing objects
  - B. Discuss uses for attributes
    1. Parts list
    2. Bill of materials
    3. Price list
  - C. Discuss requirements for use of attributes
    1. Object must be a block
    2. Define attributes for the block
    3. Text file reader for post-processing of extracted attribute data

II. Discuss Creation of Attributes
  - A. Demonstrate the procedure for creating attribute definition (DDATTDEF command)
    1. Describe tag
    2. Describe prompt
    3. Describe value information
    4. Describe text formatting
    5. Describe location
    6. Describe optional definitions
  - B. Demonstrate the procedure for associating attribute with block definition
  - C. Demonstrate procedure for inserting block into drawing
  - D. Demonstrate the procedure for entering attribute data for specific block

III. Discuss Extracting Data from an Attribute in a Drawing
  - A. Demonstrate the procedure for using the ATTEXT command
  - B. Discuss file format
    1. Comma Delimited File (CDF)
    2. Space Delimited File (SDF)
    3. Drawing Interchange File (DXF)

C. Discuss using a template file for extracting the data

D. Demonstrate the procedure for opening a text processing program (e.g., WORDPAD or NOTEPAD)

CAD-F14-LE
Use Drawing Feature Attributes
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Perform attribute operations on a drawing, including:
   (1) Defining the attributes;
   (2) Inserting the attributes;
   (3) Extracting the attribute information; and,
   (4) Performing a post analysis on the extracted attribute information.

CAD-F15

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F15

Subject: **Computer-Aided Drafting & Design** **Time: 5 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Obtain 3D Model Property Data

Objective(s):

Upon completion of this unit the student will be able to:
a. Identify surface properties;
b. Extract surface properties;
c. Identify mass properties; and,
d. Extract mass properties.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F15-HO)
MASTER Laboratory Exercise (CAD-F15-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"
CAD-F10	"Understand Procedure to Print/Plot a Drawing"
CAD-F11	"Use Standard Layering Techniques"

CAD-F12 "Create Mechanical CAD Drawings"
CAD-F13 "Create 3D Mechanical Models"
CAD-F14 "Use Drawing Feature Attributes"

Introduction:

Mass and surface property calculations are useful for generating often computationally difficult data which will be used at a later time for engineering simulations describing how the machine will behave under static or dynamic conditions. It is absolutely essential that the student verify all mass and surface computations using independent sources. In some cases, large errors can be generated if caution is not taken with respect to the modeling process.

Presentation Outline:

I. Define Surface Properties
  A. Coplanar and non-coplanar (2D) regions
    1. ***Area:*** the enclosed 2D space of a surface or region
    2. ***Perimeter:*** the total length of the inside and outside loops of a region
    3. ***Bounding box:*** the maximum coordinates that enclose the region
    4. ***Centroid:*** 2D or 3D coordinate that is the center of the area
  B. Coplanar (2D) regions: regions must be coplanar with the X-Y plane of the current UCS
    1. ***Moment of inertia:*** the area moment of inertia for regions
      a. (Moments of Inertia) = (area) x $(\text{radius})^2$ [units: distance^4]
    2. ***Principal moments and directions about a centroid:*** At the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.

II. Define Mass Properties (for 3D Solids)
  A. ***Mass:*** the measure of the inertia of a body. Computed from the density and volume of the solid.
  B. ***Volume:*** the total amount of 3D space that a solid occupies
  C. ***Bounding box:*** defined by the diagonally opposite corners of a 3D box that encloses the solid
  D. ***Centroid:*** a 3D point that is the center of mass for solids
  E. ***Mass moments of inertia:*** (Mass moment of inertia) = (mass) x $(\text{radius}_{\text{axis}})^2$ [units: mass x distance^2]

F. ***Products of inertia:*** (Product of inertia $_{YZ,XZ}$) = (mass) x (distance $_{\text{centroid to YZ}}$) x (distance $_{\text{centroid to XZ}}$) [units: mass x distance^2]

G. ***Radii of gyration:*** another way of indicating the moments of inertia of a solid.

1. (Radii of gyration) = ((Moment of inertia)/(mass))$^{1/2}$ [units: distance]

H. ***Principal moments and X,Y,Z directions about a centroid:*** at the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.

III. Discuss the Method for Computing the Surface/Mass Properties

A. Demonstrate the procedure for assigning a material type to the object (3D solids only)

1. Material type determines the density
2. AutoCAD version 14 uses a generic material with a density = 1 for all solids

B. Demonstrate the procedure for using the MASSPROP command

C. Demonstrate the procedure for writing property data to an external file

---

Practical Application:

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Perform mass/surface property calculations on a simple 3D object. Calculate the same properties manually and compare values. Compute the percent error.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F16) dealing with using CAD dimensioning features.

CAD-F15-HO
Obtain 3D Model Property Data
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify surface properties;
- b. Extract surface properties;
- c. Identify mass properties; and,
- d. Extract mass properties.

Module Outline:

- I. Define Surface Properties
  - A. Coplanar and non-coplanar (2D) regions
    - 1. ***Area:*** the enclosed 2D space of a surface or region
    - 2. ***Perimeter:*** the total length of the inside and outside loops of a region
    - 3. ***Bounding box:*** the maximum coordinates that enclose the region
    - 4. ***Centroid:*** 2D or 3D coordinate that is the center of the area
  - B. Coplanar (2D) regions: regions must be coplanar with the X-Y plane of the current UCS
    - 1. ***Moment of inertia:*** the area moment of inertia for regions
      - a. (Moments of Inertia) = (area) x $(\text{radius})^2$ [units: distance^4]
    - 2. ***Principal moments and directions about a centroid:*** At the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.
- II. Define Mass Properties (for 3D Solids)
  - A. ***Mass:*** the measure of the inertia of a body. Computed from the density and volume of the solid.
  - B. ***Volume:*** the total amount of 3D space that a solid occupies
  - C. ***Bounding box:*** defined by the diagonally opposite corners of a 3D box that encloses the solid
  - D. ***Centroid:*** a 3D point that is the center of mass for solids
  - E. ***Mass moments of inertia:*** (Mass moment of inertia) = (mass) x $(\text{radius}_{\text{axis}})^2$ [units: mass x distance^2]

F. ***Products of inertia:*** (Product of inertia $_{YZ,XZ}$) = (mass) x (distance $_{\text{centroid to } YZ}$) x (distance $_{\text{centroid to } XZ}$) [units: mass x distance^2]

G. ***Radii of gyration:*** another way of indicating the moments of inertia of a solid.

  1. (Radii of gyration) = ((Moment of inertia)/(mass))$^{1/2}$ [units: distance]

H. ***Principal moments and X,Y,Z mirections about a centroid:*** at the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.

III. Discuss the Method for Computing the Surface/Mass Properties

  A. Demonstrate the procedure for assigning a material type to the object (3D solids only)

    1. Material type determines the density
    2. AutoCAD version 14 uses a generic material with a density = 1 for all solids

  B. Demonstrate the procedure for using the MASSPROP command

  C. Demonstrate the procedure for writing property data to an external file

CAD-F15-LE
Obtain 3D Model Property Data
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Perform mass/surface property calculations on a simple 3D object. Calculate the same properties manually and compare values. Compute the percent error.

CAD-F16

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F16

Subject: **Computer-Aided Drafting & Design** **Time: 10 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Use CAD Dimensioning Features

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify dimensioning variables;
b. Set dimensioning variables;
c. Dimension drawings using CAD;
d. Use dimensioning standards with CAD; and,
e. Modify CAD dimensions.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F16-HO)
MASTER Laboratory Exercise (CAD-F16-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.
ANSI Y14.5M - "Dimensioning and Tolerancing"

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"

CAD-F10	**“Understand Procedure to Print/Plot a Drawing”**
CAD-F11	**“Use Standard Layering Techniques”**
CAD-F12	**“Create Mechanical CAD Drawings”**
CAD-F13	**“Create 3D Mechanical Models”**
CAD-F14	**“Use Drawing Feature Attributes”**
CAD-F15	**“Obtain 3D Model Property Data”**

Introduction:

Dimensioning with CAD software can greatly simplify the drawing process as compared to manual dimensioning. But attention should be focused on the correct application of dimensioning according to the ANSI standards.

Presentation Outline:

- I. Discuss Elements of Dimensions
  - A. Demonstrate and show extension lines
  - B. Demonstrate and show dimension lines
  - C. Demonstrate and show dimension text
  - D. Demonstrate and show arrowheads
  - E. Demonstrate and show leaders
  - F. Demonstrate and show standard dimension feature sizes (according to ANSI Y14.5M standards)
- II. Discuss Dimension Styles
  - A. Demonstrate the procedure for changing dimension styles
    - 1. Change geometry dimension styles
    - 2. Change format dimension styles
    - 3. Change annotation dimension styles
      - a. Demonstrate the procedure for altering the units
      - b. Demonstrate the procedure for creating tolerance symbols
      - c. Demonstrate the procedure for changing the dimension text style
  - B. Demonstrate the procedure for creating a dimension style
    - 1. Discuss parent/child dimension styles
    - 2. Create parent dimension style
    - 3. Create child dimension style
- III. Discuss the Application of Dimensions to a 2D Drawing
  - A. Demonstrate the procedure for setting/creating the dimension style
  - B. Demonstrate the procedure for setting object snap
  - C. Demonstrate the procedure for applying dimensions
    - 1. Apply linear dimensions
    - 2. Apply angular dimensions
    - 3. Apply leaders
    - 4. Apply radial/diametrical dimensions

        5. Apply tolerance dimensions
        6. Apply geometric dimension codes
        7. Apply baseline dimensions
        8. Apply continuous dimensions
        9. Apply ordinate dimensions
    D. Demonstrate the procedure for modifying an existing dimension
        1. Demonstrate the procedure for modifying the properties of a dimension
        2. Demonstrate the procedure for using the GRIPS command to modify dimensions

---

Practical Application:

Students will be given classwork and homework assignments in which they must :

a) Answer review questions;

b) Create dimension style for standard, tolerance, and GDT dimensions in English (inches) and Metric (millimeters) units. Create parent and child relationships. Use ANSI Y14.5M standard as basis; and,.

c) Create mechanical drawings using orthographic projection. Apply dimensions to the drawing using proper CAD techniques and ANSI Y14.5M standards adherence.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (CAD-F17) dealing with performing CAD customization procedures.

CAD-F16-HO
Use CAD Dimensioning Features
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

- a. Identify dimensioning variables;
- b. Set dimensioning variables;
- c. Dimension drawings using CAD;
- d. Use dimensioning standards with CAD; and,
- e. Modify CAD dimensions.

Module Outline:

- I. Discuss Elements of Dimensions
  - A. Demonstrate and show extension lines
  - B. Demonstrate and show dimension lines
  - C. Demonstrate and show dimension text
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    - 3. Change annotation dimension styles
      - a. Demonstrate the procedure for altering the units
      - b. Demonstrate the procedure for creating tolerance symbols
      - c. Demonstrate the procedure for changing the dimension text style
  - B. Demonstrate the procedure for creating a dimension style
    - 1. Discuss parent/child dimension styles
    - 2. Create parent dimension style
    - 3. Create child dimension style
- III. Discuss the Application of Dimensions to a 2D Drawing
  - A. Demonstrate the procedure for setting/creating the dimension style
  - B. Demonstrate the procedure for setting object snap
  - C. Demonstrate the procedure for applying dimensions
    - 1. Apply linear dimensions
    - 2. Apply angular dimensions
    - 3. Apply leaders
    - 4. Apply radial/diametrical dimensions

    5. Apply tolerance dimensions
    6. Apply geometric dimension codes
    7. Apply baseline dimensions
    8. Apply continuous dimensions
    9. Apply ordinate dimensions

D. Demonstrate the procedure for modifying an existing dimension
    1. Demonstrate the procedure for modifying the properties of a dimension
    2. Demonstrate the procedure for using the GRIPS command to modify dimensions

CAD-F16-LE
Use CAD Dimensioning Features
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must :

a) Answer review questions;

b) Create dimension style for standard, tolerance, and GDT dimensions in English (inches) and Metric (millimeters) units. Create parent and child relationships. Use ANSI Y14.5M standard as basis; and,.

c) Create mechanical drawings using orthographic projection. Apply dimensions to the drawing using proper CAD techniques and ANSI Y14.5M standards adherence.

CAD-F17

COMPUTER-AIDED DRAFTING & DESIGN SERIES

MASTER Technical Module No. CAD-F17

Subject: **Computer-Aided Drafting & Design** **Time: 10 Hrs.**

Duty: **Use Computer-Aided Drafting System**
Task: Perform CAD Customization Procedures

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify customization techniques and procedures; and,
b. Use customization techniques and procedures.

Instructional Materials:

Computer (with necessary hardware/software/peripherals)
Optional: CAD software (loaded properly on computer)
MASTER Handout (CAD-F17-HO)
MASTER Laboratory Exercise (CAD-F17-LE)

References:

An introduction to CAD textbook corresponding to the specific software used.

Student Preparation:

Students should have previously completed the following Technical Modules:

CAD-F1	"Start and Exit a Software Program"
CAD-F2	"Demonstrate Proper File Management Techniques"
CAD-F3	"Use Directory Structure"
CAD-F4	"Open, Save, and Exit a Drawing File"
CAD-F5	"Utilize Drawing Setup Procedures"
CAD-F6	"Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)"
CAD-F7	"Use Text for Drawing Annotation"
CAD-F8	"Use Viewing/Display Commands"
CAD-F9	"Control Object Properties"
CAD-F10	"Understand Procedure to Print/Plot a Drawing"
CAD-F11	"Use Standard Layering Techniques"
CAD-F12	"Create Mechanical CAD Drawings"
CAD-F13	"Create 3D Mechanical Models"

CAD-F14 "Use Drawing Feature Attributes"
CAD-F15 "Obtain 3D Model Property Data"
CAD-F16 "Use CAD Dimensioning Features"

Introduction:

The ability of a CAD drafter to maneuver through the directories, folders, and network drives of a computer is a required skill in the engineering and design industry today. Often special folders must be set up in order to organize the work done for a new job or task.

Additionally, CAD programs today offer unprecedented customization and manipulation of the program, specifically the user interface. Properly customizing the CAD program can greatly increase individual efficiency, departmental efficiency, and minimize errors. This all equates to better, faster drafting; thus saving money over the long term.

Presentation Outline:

- I. Discuss Customization of Menus
  - A. Discuss using menu files
  - B. Discuss menu file structure
    - 1. Menu file group name
    - 2. Pointing-device button menu
    - 3. System pointing device menu
    - 4. Pull-down/cursor menu areas
    - 5. Toolbar definitions
    - 6. Image tile menu area
    - 7. Screen menu area
    - 8. Tablet menu area
    - 9. Accelerator key definitions
  - C. Demonstrate menu file editing
    - 1. Select editing program (e.g., Notepad)
    - 2. Demonstrate editing techniques
  - D. Discuss menu item syntax
  - E. Discuss loading menu files
    - 1. Demonstrate loading from CAD program
    - 2. Demonstrate the procedure for loading at startup
    - 3. Demonstrate for loading multiple menus
- II. Discuss Customization of Toolbars
  - A. Demonstrate the procedure for customizing a toolbar
  - B. Demonstrate the procedure for creating anew toolbar
  - C. Demonstrate the procedure for creating toolbar button graphics
  - D. Discuss loading custom toolbar files

III. Discuss Creating Profiles
    A. Demonstrate customizing the display
        1. Demonstrate setting the display color
        2. Demonstrate setting the display fonts
        3. Demonstrate setting the general display options
    B. Demonstrate customizing the pointer device
    C. Discuss setting the file locations
IV. Discuss Creating a Drawing Template
    A. Demonstrate setting the layers
    B. Demonstrate setting the dimension styles
    C. Discuss including special blocks (internal)
    D. Demonstrate including/creating linetypes
V. Discuss Creating Command Aliases (Shortcut Command Syntax Used for Commonly Executed Commands)
VI. Discuss Customizing the Printer Configuration
    A. Demonstrate setting the printers
    B. Demonstrate setting the plot settings (rotation, plot origin, paper sizes, etc.)

Practical Application:

Students will be given classwork and homework assignments in which they must:
a) Answer review questions;
b) Create dimension style for standard, tolerance, and GDT dimensions in English (inches) and Metric (millimeters) units. Create parent and child relationships. Use ANSI Y14.5M standard as basis; and,
c) Create mechanical drawings using orthographic projection. Apply dimensions to the drawing using proper CAD techniques and ANSI Y14.5M standards adherence.

Evaluation and/or verification:

Successful completion of this technical module will be based on the student's successful completion of the Practical Application assignments (see above).

Summary:

Review the main lesson points and discuss examples related to Practical Application assignments. Convene class discussion and answer student questions.

Next Lesson Assignment:

This completes the series of Computer-Aided Drafting and Design technical modules.

CAD-F17-HO
Perform CAD Customization Procedures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify customization techniques and procedures; and,
b. Use customization techniques and procedures.

Module Outline:

I. Discuss Customization of Menus
    A. Discuss using menu files
    B. Discuss menu file structure
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        5. Toolbar definitions
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        3. Demonstrate setting the general display options
    B. Demonstrate customizing the pointer device
    C. Discuss setting the file locations

IV. Discuss Creating a Drawing Template
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CAD-F17-HO
Perform CAD Customization Procedures
Attachment 1: MASTER Handout

Students will be given classwork and homework assignments in which they must:
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CE

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

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Computer-Aided Drafting & Design Series
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MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

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MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, PALOS HILLS, IL
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Center for Contemporary Technology

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Manufacturing in Moraine Valley

The metropolitan Chicago area, including northwestern Indiana, is among the most heavily industrialized areas of the United States. The neighboring Moraine Valley area is home to hundreds of the small- to medium-sized companies that supply the larger industrial concerns, including design, fabrication, metal-working and parts-assembly firms. The diversity of industry in the region and the continual need for qualified entry-level technicians and retraining of current workers has created a great demand for the development of industrial training and the services of Moraine Valley Community College and its Center for Contemporary Technology.

Moraine Valley Community College (MVCC) and the Center for Contemporary Technology (CTT)

Moraine Valley Community College (MVCC) is a public, postsecondary institution serving all or part of 26 communities in the southwest suburban area of Cook County, representing a population of more than 380,000. Located 25 miles southwest of downtown Chicago in Palos Hills, the college is the fourth largest community college in Illinois and serves a diverse student body drawn from the surrounding communities. The focal point for business and industry training in Moraine Valley is the 124,000 s.f. Center for Contemporary Technology (CTT). Opened in 1988, the Center is among the finest and most diverse advanced technology centers (ATC's) in the nation, with over $6 million of equipment and technology to provide training and education in Automated Manufacturing; Automotive Technology; Computer-Aided Design; Corrosion Mitigation; Electronics/Telecommunications; Environmental Control Technology; Information Management; Machining; Mechanical & Fluid Power Maintenance; Non-Destructive Evaluation; and Welding.

Development Team

- **Project Director**: Richard Hinckley, PhD., Dean of Instruction for Business and Industrial Technology and manager of the Center for Contemporary Technology, served as director for the MASTER project.
- **Subject Matter Expert**: Charles H. Bales, Instructor of Mechanical Design/Drafting, had program responsibility for developing skill standards and course/program materials for the mechanical design/drafting component of the MASTER project. Professor Bales also served as lead instructor for the MASTER pilot program in Computer-Aided Drafting and Design (CADD) Technician.
- **Skills Validation Coordinator**: Richard Kukac, MPA, Associate Dean of Instruction of Business and Industrial Technology, coordinated the industry skills verification process for MASTER and facilitated the industry validation sessions with teams of expert practitioners from the skill area.

Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, MASTER project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).**

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

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CAD-A1-HO
Perform Basic Arithmetic Operations
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Add, subtract, multiply, and divide real numbers;
b. Add, subtract, multiply, and divide fractions; and,
c. Convert real numbers to fractional equivalents and vice versa.

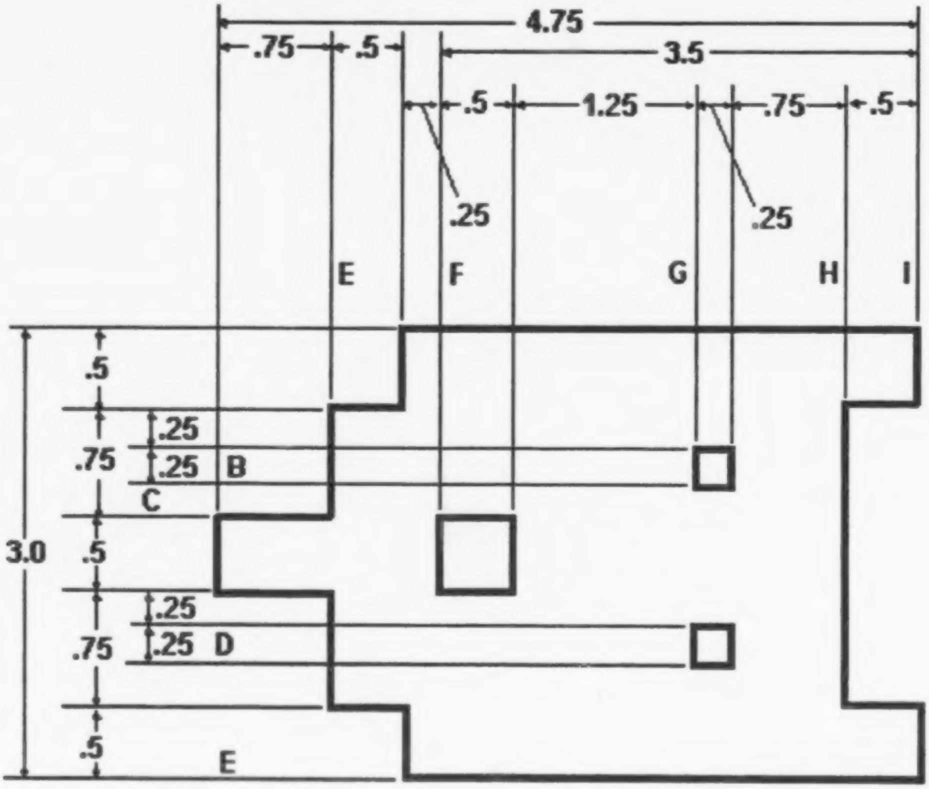
Module Outline:

I. Add, Subtract, Multiply, and Divide Whole Numbers
   A. Addition of whole numbers
   B. Subtraction of whole numbers
   C. Multiplication of whole numbers
   D. Division of whole numbers
   E. Hierarchy of operations
II. Add, Subtract, Multiply, and Divide Fractions
   A. Common operations
      1. Least common denominator
      2. Factoring for reduction
      3. Improper fractions
      4. Mixed numbers
   B. Addition
   C. Subtraction
   D. Multiplication
   E. Division
III. Add, Subtract, Multiply, and Divide Decimals
   A. Aligning the decimal (addition and subtraction)
   B. Moving the decimal
      1. In division, move the decimal to the right until it is eliminated in the divisor. Move the decimal the same number of places to the right in the dividend.
      2. In multiplication, count the total number of decimals places in the two numbers being multiplied. Beginning in the product at the *right-most digit*, count off the same number of places and place the decimal.
IV. Real numbers (with decimals)
   A. Round real numbers
   B. Identify significant digits
   C. Add real numbers
   D. Subtract real numbers

- E. Multiply real numbers
- F. Express numbers in scientific notation
- G. Divide real numbers

V. Conversion
- A. Express decimals as fractions
- B. Express fractions as decimals
- C. Express a decimal or fraction as a percent
- D. Express a percent as a decimal or fraction

CAD-A1-LA
Perform Basic Arithmetic Operations
Attachment 2: MASTER Laboratory Aid


4.75
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E

CAD-A1-LE
Perform Basic Arithmetic Operations
Attachment 3: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;

b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,

c) Solve word problems (based on technical applications).

CAD-A2-HO
Compute Unit Conversions
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Convert English units to metric units and vice versa; and,
- b. Calculate unit conversion ratios.

Module Outline:

- I. Metric (SI) System of Measurement
  - a. Metric units
  - b. Conversions within the metric system (e.g. meter to millimeter, gram to kilogram)
- II. English System of Measurement
  - A. English units
  - B. Conversions within the English system (e.g. feet to miles, ounce to pound)
- III. System Conversions
  - A. Conversion factors
  - B. Conversion from metric to English
  - C. Conversion from English to metric

CAD-A2-LE
Compute Unit Conversions
Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

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c) Solve word problems (based on technical applications).

CAD-A3-HO
Perform Basic Trigonometric Operations
Attachment 1: MASTER Handout

Objective(s):

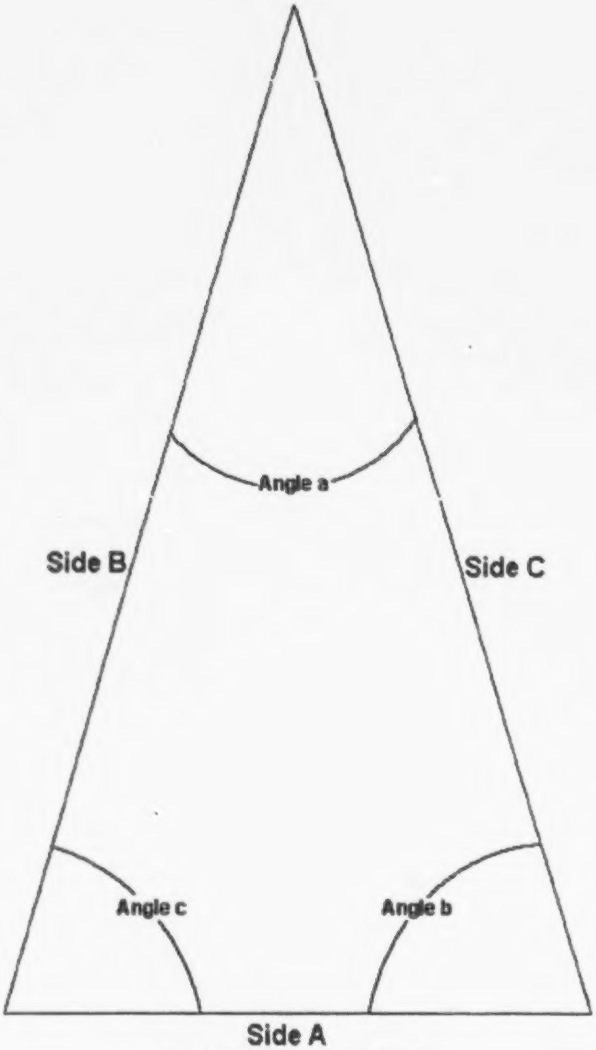
Upon completion of this unit the student will be able to:

a. Use trigonometric functions to calculate angles; and,
b. Use trigonometric functions to calculate linear distances.

Module Outline:

I. Angles
  A. Determine the quadrant of a given angle
  B. Identify the coterminal angles
  C. Express the degree measure of an angle as a radian measure and vice-versa
II. Trigonometric Functions
  A. Define trigonometric functions (ratios)
  B. Determine the trigonometric ratios of acute angles of a right triangle
  C. Find the value of trigonometric ratios of angles between 0° and 90°
  D. Find the trigonometric ratios for obtuse angles
III. Solve Triangles (Determine Lengths and/or Angles)
  A. Solve right triangles
  B. Solve oblique triangles
    1. Solve using Law of Sines
    2. Solve using Law of Cosine

CAD-A3-LA
Perform Basic Trigonometric Operations
Attachment 2: MASTER Laboratory Aid


Angle a
Side B
Side C
Angle c
Angle b
Side A

Basic Triangle - CAD-A3

CAD-A3-LE
Perform Basic Trigonometric Operations
Attachment 3: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Solve given mathematical problems, showing all work;

b) Show which mathematical properties and/or laws can be used to solve given mathematical problems; and,

c) Solve word problems (based on technical applications).

CAD-A4-HO
Use the Cartesian Coordinate System
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Read and understand Cartesian coordinate data; and,
b. Plot Cartesian coordinate data.

Module Outline:

I. Plot Cartesian Coordinate Data Points on Cartesian Graph Paper
II. Convert Graphical Data into Cartesian Coordinate Pairs
III. Construct Two-dimensional (Flat) Shapes Using Cartesian Coordinate Data
    A. Use absolute Cartesian coordinate transformations
    B. Use relative Cartesian coordinate transformations

CAD-A4-LE
Use the Cartesian Coordinate System
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Plot data on graph paper given Cartesian coordinate data;

b) Convert graphical data into Cartesian coordinate pairs; and,

c) Construct two-dimensional shapes on graph paper given Cartesian coordinate data.

CAD-A5-HO
Use the Polar Coordinate System
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

- **a. Read and understand polar coordinate data;**
- **b. Interpret polar coordinate data; and,**
- **c. Plot polar coordinate date;**

Module Outline:

I. Plot Polar Coordinate Data Points on Polar Graph Paper
II. Convert from Polar Coordinates to Cartesian Coordinates, and Vice-Versa
III. Construct Two-dimensional (Flat) Shapes Using Polar Coordinate Data
    A. Use absolute polar coordinate transformations
    B. Use relative polar coordinate transformations
IV. Construct Two-dimensional (Flat) Shapes Using a Combination of Cartesian and Polar Coordinate Data

CAD-A5-LE
Use the Polar Coordinate System
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Plot data on graph paper;

b) Convert from polar coordinates to Cartesian coordinate and vice-versa given the respective coordinate pairs (all work must be shown); and,

c) Construct two-dimensional shapes on graph paper given polar and Cartesian coordinate data.

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	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
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F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

CAD FM8

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CAD-B1-HO
Use Drawing Media and Related Drafting Materials
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Select drawing media; and,
- b. Select related drafting materials

Module Outline:

- I. Drawing Media
  - A. Types
    - 1. Drawing papers
      - a. 100% rag content
      - b. White or light cream
      - c. For pencil drawing
      - d. Can be used for CAD plotting
    - 2. Ink papers
      - a. Similar to 100% rag content paper
      - b. Thicker ply: 2-ply, 3-ply, or 4-ply
      - c. White
      - d. Used for CAD plotting
    - 3. Tracing papers/vellums
      - a. Transparent
      - b. Used for reproduction
      - c. Used for pencil or ink
      - d. Good for blueprinting
    - 4. Polyester film
      - a. Superior material, expensive
      - b. Transparent
      - c. Easy erasing, no ghost marks
      - d. Used for pencil or ink
      - e. Can be used for CAD plotting
  - B. Paper sizes
    - 1. Standard U.S. sizes (ANSI)
      - a. A - 8.5" x 11"
      - b. B - 11" x 17"
      - c. C - 17" x 24"
      - d. D - 22" x 34"
      - e. E - 34" x 44"
    - 2. International sizes (mm) (ISO)
      - a. A4 - 210 x 297
      - b. A3 - 297 x 420

        - c. A2 - 420 x 594
        - d. A1 - 594 x 841
        - e. A0 - 841 x 1189

- II. Drafting Materials
  - A. Pencils/pens
    - 1. Leads
      - a. Range from 9H to 7B
      - b. H - hard leads
      - c. B - soft leads
      - d. Most often used: 2H, HB, B
    - 2. Lead holder
    - 3. Mechanical pencil
    - 4. Ink pens
  - B. Scales (see B-2 for further instruction)
    - 1. Mechanical/Mechanical Draftsman scale
      - a. Open-divided
      - b. Inch units
    - 2. Engineers/Civil Engineers scale
      - a. Full-divided
      - b. English units
    - 3. Metric scale
  - C. Instruments
    - 1. Compass
    - 2. Triangles
      - a. 30°-60°-90°
      - b. 45°-45°-90°
      - c. Adjustable
    - 3. Dividers
  - D. Straight-edges
    - 1. Main drafting straight-edge
      - a. T-square
      - b. Parallel-ruling
      - c. Drafting machine
    - 2. French curve
    - 3. Adjustable curve
  - E. Miscellaneous
    - 1. Templates
    - 2. Eraser
    - 3. Eraser pad
    - 4. Eraser brush
    - 5. Eraser shield
    - 6. Protractor
    - 7. Lettering guide (see D-4 for further instructions)
    - 8. Drafting tape
    - 9. Lead sharpener/pointer

CAD-B1-LE
Use Drawing Media and Related Drafting Materials
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Identify types of drafting equipment;
b) Demonstrate proper techniques for using equipment; and,
c) Identify specific usage for equipment.

CAD-B2-HO
Use Measuring Scales
Attachment 1: **MASTER** Handout

Objective(s)

Upon completion of this unit the student will be able to:
- a. Identify types of scales;
- b. Select appropriate scale; and,
- c. Use scales to measure and transfer dimensions.

Module Outline:

- I. Discuss Types of Scales for Engineering Drawing
  - A. Discuss Mechanical Engineers scale
    - 1. Discuss uses for Mechanical Engineers scale
    - 2. Discuss open-divided scales
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  - B. Discuss Engineers scale (Civil Engineers scale)
    - 1. Discuss uses for Engineers scale
    - 2. Discuss full-divided scales
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
  - C. Discuss Metric scale
    - 1. Discuss uses for Metric scale
    - 2. Discuss converting between metric units (mm to cm, etc.) with the Metric scale
    - 3. Demonstrate the procedure for measuring lengths at a given scale
    - 4. Demonstrate the procedure for drawing lines at a specified length at a given scale
- II. Discuss Converting from Inches to Feet Using Mechanical Engineers and Engineers Scales
- III. Discuss Converting Distances from English to Metric Units (Inches to MM, MM to Inches, Etc.)
- IV. Discuss Drawing Scale
  - A. Discuss preferred scales
    - 1. Inch scales
    - 2. Metric scales

3. English scales (in., ft., yd., etc.)

B. Discuss standard notations for scales

CAD-B2-LE
Use Measuring Scales
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete worksheets with scaled measurements and scaled drawing using Mechanical Engineers, Engineers, and Metric scales.

CAD-B3-HO
Identify Drafting Line Styles and Weights
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

- a. Identify types of scales;
- b. Select appropriate scale; and,
- c. Use scales to measure and transfer dimensions.

Module Outline:

- I. Discuss Types of Scales for Engineering Drawing
  - A. Discuss Mechanical Engineers scale
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  - C. Discuss Metric scale
    - 1. Discuss uses for Metric scale
    - 2. Discuss converting between metric units (mm to cm, etc.) with the Metric scale
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- IV. Discuss Drawing Scale
  - A. Discuss preferred scales
    - 1. Inch scales
    - 2. Metric scales

    3. English scales (in., ft., yd., etc.)
B. Discuss standard notations for scales

CAD-B3-LE
Identify Drafting Line Styles and Weights
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Identify line types;
b) Describe and provide example uses for each line type; and
c) Draw each line type separately and in its proper application.

CAD-B4-HO
Prepare Title Blocks and Other Drafting Formats
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

a. Identify and prepare title blocks;
b. Identify and prepare bill of material/parts lists; and,
c. Identify and prepare revision history blocks.

Module Outline:

I. Title Blocks
   A. Identify major areas included in a title block
      1. Name of object or assembly
      2. Name of manufacturer
      3. Name of drafter
      4. Name of checker
      5. Name of chief engineer or other supervisor
      6. Scale of the drawing
      7. Drawing number or code
   B. Identify optional areas
      1. Global dimension tolerance specifications
      2. Material type
      3. Manufacturing information, e.g., heat treatment, surface finish, hardness, etc.
      4. Superceding and/or superceded drawing numbers
      5. Other industry-specific information
   C. Draw title blocks of various sizes and orientations
      1. Orientation
         a. Across bottom of sheet (horizontal)
         b. Bottom right corner
         c. Across right size of sheet (vertical)
      2. Minimum letter heights in title block areas (ANSI Y14.2M-1979 (R1987))
         a. Drawing number/code
            (1) .290" (7mm) for drawing sizes larger than 17" x 22"
            (2) .240" (7mm) for drawing sizes equal to or less than 17" x 22"
         b. Drawing title: .240" (7mm) for all drawing sizes
         c. All other title block text:
            (1) .140" (5mm) for drawing sizes larger than 17" x 22"

- (2) .120" (3.5mm) for drawing sizes equal to or less than 17" x 22

II. Bill of Material/Parts List
- A. ***Purpose:*** itemized list of the several parts which comprise the assembly drawing and can be found in detail drawings
- B. Location
  - 1. Included on drawing sheet with assembly drawing
    - a. On top of title block, attached
    - b. Above title block, attached to border
  - 2. On separate paper (8.5" x 11")
- C. Format
  - 1. Each part must have the following information: part number, part name, total number required in the assembly, and material
  - 2. Other information may include: pattern numbers, stock sizes, catalog numbers, weights, nominal dimensions, etc.

III. Revision History Block
- A. ***Purpose:*** to provide complete historical information concerning the design and modifications of the part
- B. Location
  - 1. Attached to the title block
  - 2. Above title block, attached to border
- C. Format
  - 1. Each block must contain the following information: description of the correction or modification, date of revision, supervisor's check area, part number
  - 2. Other information may include: drafter identification, drawing code, etc.

CAD-B4-LE
Prepare Title Blocks and Other Drafting Formats
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Draw title blocks of various sizes, shapes, and orientations;

b) Create bills of materials of various sizes, shapes, and orientations; and,

c) Create revision blocks of various sizes, shapes, and orientations.

CAD-B5-HO
Create Technical Sketches
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify and create orthographic sketches (single and multiview);
- b. Identify and create oblique sketches;
- c. Identify and create axonometric sketches (iso-, tri-, and diametric);
- d. Identify and create perspective sketches (1, 2, and 3-point); and,
- e. Understand and apply techniques of sketching.

Module Outline:

- I. Line Work
  - A. Types of sketched lines
    - 1. Construction lines
    - 2. Visible lines
    - 3. Other lines (hidden, center, phantom, etc.)
  - B. Technique of sketching
    - 1. Sketching straight lines
      - a. Drawing vertical lines
      - b. Drawing horizontal lines
      - c. Maintaining proportion
    - 2. Sketching circles, curves and ellipses: Box Method
    - 3. Discuss comparison to artistic sketching
      - a. Typically no shading in technical sketching
      - b. Concerned with maintaining proper proportion and scale
- II. Orthographic Sketches
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a) Three-dimensional object (object to be projected)
      - b) Projection plane
      - c) Projectors
      - d) Projected image of the object: image projected onto the projection plane
    - 2. Representing hidden features
    - 3. Terminology
      - a) Normal surfaces
      - b) Oblique surfaces
      - a) Edges
  - B. Single View Orthographic Sketch
    - 1. Maintain scale and proportion

    - 2. Maintain straightness of lines
    - 3. Use construction lines – "blocking-in the drawing"
  - C. Multiview Orthographic Sketch
    - 1. Discuss the "glass box" analogy
    - 2. Alignment of views
      - a) Six principal views: top, front, right-side, left-side, bottom, back
      - b) Three standard views: top, front, right-side
    - 3. Discuss transferring dimensions between views
- III. Pictorial Sketches
  - A. Types of pictorial sketches
    - 1. Oblique projection
    - 2. Axonometric projection
    - 3. Perspective projection
  - B. Oblique sketches
    - 1. Technique
      - a) Front surface (parallel to viewing plane) drawn "flat"
      - b) All surfaces parallel to front surface drawn "flat"
      - c) Depth projected back on receding, parallel lines
        - (1) Varying angle of receding lines changes viewing position
        - (2) Typical angle is 45° (measured from the right-side horizontal line in the CCW direction.)
      - d) Projection of curves (circles, arcs, ellipses)
        - (1) On front surface and surfaces parallel to front surface: curves are true shape.
        - (2) On other surfaces: circles and circular arcs appear as ellipses.
        - (3) Drawing method: use box method, maintaining angle for receding lines
      - e) Selection of front surface
        - (1) Minimize curves
        - (2) Show most complicated profile
        - (3) Show most detail in front surface
    - 2. Types of oblique sketches
      - a) Cabinet projection: depth drawn at half scale
      - b) Cavalier projection: depth drawn at full scale
  - C. Axonometric sketches
    - 1. Types of axonometric sketches
      - a) Isometric: angles between three axes are equal to 120° (sum = 360°)
      - b) Trimetric: angles between three axes are unequal (sum = 360°)
      - c) Dimetric: angle between two axes are equal (sum = 360°)
    - 2. Technique

- a) All normal surfaces appear as oblique surfaces
- b) Receding lines drawn parallel to axonometric axes
- c) Length of receding lines
  - (1) Isometric scale = 80% true length
  - (2) Ordinary scale = 100% true length (full scale)
- d) Curves on all surfaces appear as ellipses
- e) Discuss box construction method
- f) Discuss using isometric grid paper

D. Perspective sketches
- 1. Types of perspective sketches
  - a) One-point perspective: single vanishing point
  - b) Two-point perspective: two vanishing points
  - c) Three-point perspective: three vanishing points
- 2. Technique
  - a) Components of all perspective drawings
    - (1) Horizon line
      - (a) Discuss function
      - (b) Discuss placement
    - (2) Vanishing points
      - (a) Discuss function
      - (b) Discuss placement
    - (3) Location of object affects viewpoint
      - (a) In relation to horizon line (above, below, on horizon line)
      - (b) In relation to vanishing points (left, right, or center)
    - (4) Length of receding (converging) lines
- 3. One-point perspective
  - a) Discuss similarities to oblique projection
  - b) Vanishing point located on horizon line
  - c) Receding lines converge to vanishing point
  - d) Surfaces parallel to viewing plane drawn “flat” (as in oblique projection)
- 4. Two-point perspective
  - a) Discuss similarities to axonometric projection
  - b) Vanishing points located on horizon line
  - c) Receding lines converge to vanishing points
    - (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
    - (2) Lines projecting to the right viewing plane center project to vanishing point to the right
  - d) Vertical lines project vertically at true length
- 5. Three-point perspective
  - a) Discuss similarities to axonometric projection
  - b) Vanishing point location

    (1) Two vanishing points located on horizon line,
    (2) Third vanishing point located above or below horizon line

c) Receding lines converge to vanishing points
    (1) Lines projecting to the left of viewing plane center project to vanishing point to the left
    (2) Lines projecting to the right viewing plane center project to vanishing point to the right
    (3) Vertical lines converge to third vanishing point (point not on horizon line)

CAD-B5-LE
Create Technical Sketches
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments (in the following order) in which they must:

a) Sketch lines, circles, and curves following proper technical sketching techniques;
b) Sketch simple (three-dimensional and two-dimensional) shapes using single-view orthographic projection;
c) Sketch simple three-dimensional shapes using multiview orthographic projection;
d) Sketch more complicated objects using multiview orthographic projection;
e) Sketch simple three-dimensional objects using oblique projection (cabinet and cavalier);
f) Sketch simple three-dimensional objects using axonometric projection (iso-, tri-, and dimetric);
g) Sketch simple three-dimensional objects using perspective projection (one, two, and three-point); and,
h) Sketch complex three-dimensional objects using a variety of projection methods.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... **plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.**

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splines, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

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CAD-C1-HO
Determine Scope of Drafting Assignment
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand completion date;
b. Identify number of drawings to be completed;
c. Identify assignment requirements; and,
d. Understand drawing responsibilities.

Module Outline:

I. Discuss Mechanical Drafting Project Requirements
    A. Discuss the expected date of completion
    B. Discuss the specific requirements of the project
        1. Discuss the number of drawings that are required to be completed on the completion date
        2. Discuss the format for the drawings
            a. Determine whether the drawings must be CAD or manual drawings
            b. Determine the type of paper (bond, film, etc.)
            c. Determine the need for blueprint/reproduction
            d. Determine the desired paper size
            e. Determine the desired drawing scale
II. Discuss Additional Assignment Requirements

CAD-C1-LE
Determine Scope of Drafting Assignment
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Complete the drafting assignment following requirements discussed above.

CAD-C2-HO
Select Appropriate Drafting Techniques for Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of drawings required; and,
b. Identify types of materials needed.

Module Outline:

I. Discuss Types of Drawings Required
    A. Working drawing set
    B. Technical sketch
    C. Mechanical drawing
    D. Assembly drawing
II. Discuss Required Drawing Process
    A. CAD drawing
    B. Manual drawing
    C. Technical sketch
III. Discuss Desired Standard
    A. Industry standard
    B. National – ANSI
    C. International – ISO
    D. Other (Japanese, military, etc.)
IV. Discuss Required Supporting Materials
    A. Determine which parts catalogs are necessary
    B. Determine which reference books are necessary (e.g. *Machinery's Handbook*, ANSI standards)
    C. Determine which additional supporting materials are required

CAD-C2-LE
Select Appropriate Drafting Techniques for Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) Complete the drafting assignment following requirements discussed above.

CAD-C3-HO
Maintain Supporting Documents
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify supporting documents involved;
- b. Understand document filing system; and,
- c. Understand document responsibilities.

Module Outline:

- I. Discuss Supporting Documents Necessary for Mechanical Design
    - A. Mechanical drawings
        - 1. Detail drawings
        - 2. Manufacturing/production drawings
        - 3. Assembly drawings
    - B. Technical sketches
    - C. Copies of drawings (blueprints, microfilm, etc.)
    - D. Computer files on disk (hard disk, floppy disk, digital tape, CD, etc.)
        - 1. Drawings
        - 2. Documents
        - 3. Other (multimedia, web-based, etc.)
    - E. Bill of materials (if separate from assembly drawing)
    - F. Engineering work sheets: work detailing the equations and assumptions made in order to determine the proper working parameters and characteristics of the machine
    - G. Conceptual design work sheets: details and notes for the conceptual design stage of the design process
    - H. Miscellaneous notes
    - I. Work orders, time sheets, administrative documents
    - J. Supporting vendor pages/information: information from the supplier for various purchased parts used in the design of the machine
- II. Discuss Filing System for Support Documents
    - A. Discuss standardized coding system
        - 1. Same codes link all supporting documents
        - 2. Typically all codes indexed in large database
        - 3. Codes should include information about type of document (e.g. use D for drawings, W for engineering work sheets, V for vendor pages, etc.)
    - B. Discuss use of file codes on drawings
        - 1. Codes listed in title block
        - 2. Codes correspond to work order codes

3. **Codes are standardized within industry/company**
4. **Codes are indexed with other supporting documents**
5. **Codes are also used as file names when storing drawing files on the computer**

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splines, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

CAD-D1-HO
Understand and Apply Mechanical Drawing Methods
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand and apply multiview orthographic projection;
- b. Understand and apply section views; and,
- c. Understand and apply auxiliary views.

Module Outline:

- I. Orthographic Projection
  - A. Discuss the basics of orthographic projections
    - 1. Components
      - a. Three-dimensional object (object to be projected)
      - b. Projection plane
      - c. Projectors
      - d. Projected image of the object
    - 2. Representing hidden features
    - 3. Terminology
      - a. Normal surface
      - b. Oblique surface
      - c. Edge
  - B. Multiview orthographic projection
    - 1. Discuss the "glass box" analogy
    - 2. Six principal views: top, front, right-side, left-side, bottom, back
    - 3. Three standard views: top, front, right-side
    - 4. Discuss transferring dimensions between views
    - 5. Discuss selection and positioning of views
      - a. Clearly show contours, shapes, and features of object
      - b. Choosing a front view
        - (1) Minimize hidden lines
        - (2) Main focal point in drawing
        - (3) Relationship to other views
      - c. Selecting additional views
  - C. Standard rules and conventions
    - 1. Linetypes
      - a. Discuss types used (object, hidden, center, phantom, etc.)
      - b. Precedence of lines: (in order of priority) object, hidden, center, phantom (tie)
    - 2. Explain the use and application of partial views
    - 3. Explain the use and application of revolution conventions

        4. Discuss drafting techniques
            a. Representing surfaces, edges, and corners in various views
            b. Transferring curves between views
            c. Fillets and rounds
            d. Runouts
        5. Intersections and tangencies between surfaces and edges
            a. Cylindrical
            b. Rectangular

II. Section Views
    A. Define *section view:* an orthographic view of an object in which an imaginary slice has been made through the object thus exposing the internal features.
    B. Discuss the proper application of the cutting-plane line (CPL)
        1. Purpose: to show the path along which the object has been sliced
        2. Placement: the CPL is always placed in the unsectioned view adjacent to the section view
        3. Line type - a CPL can be a line made up of short dashes (e.g., a hidden line) or made up of a long dash separated by two short dashes (e.g., a phantom line). It should be as thick as object lines.
        4. Arrow direction - the arrows of a CPL are always at right angles to body of the line and always point in the line of sight for viewing the section view
        5. Precedence over other line types - the CPL has equal precedence to the center-line
    C. Section lining
        1. Styles - ANSI standard and alternate styles
        2. Angle of section lines
            a. Solitary object - 45°
            b. Objects in assembly with mating surfaces - alternate angles
        3. Alternate section lining (for thin features)
    D. Standard rules and conventions
        1. No hidden lines
        2. Maintain orthographic projection
        3. Discuss the sectioning of thin features (ribs, webs, etc.)
        4. Discuss cylindrical features in section (shafts, bolts, screws, pins, etc.)
        5. Aligned sections (aligning features parallel to the projection plane)
        6. Partial views
    E. Types of section views
        1. Full section

    2. Half section
    3. Revolved section
    4. Removed section
    5. Offset section
    6. Broken-out section
  - F. Conventional breaks
    1. Round objects
    2. Rectangular objects
- III. Auxiliary Views
  - A. Definitions
    1. ***Primary auxiliary views:*** an orthographic view parallel to one of the principal planes of projection and inclined to the other two
    2. ***Secondary auxiliary views:*** an orthographic view projected from an another auxiliary view; an orthographic view that is inclined to all principal views
  - B. Projecting onto the auxiliary plane
    1. Placement of the auxiliary plane - parallel to the edge-view of the surface to be shown as true shape in the auxiliary view
    2. Projectors from the source view are perpendicular to the auxiliary plane
    3. Discuss how projector distances are measured in the auxiliary view
    4. Discuss how arcs, circles, and curves are projected into the auxiliary view
  - C. Classification
    1. Depth auxiliary views
    2. Height auxiliary views
    3. Width auxiliary views
  - D. Standard rules and conventions
    1. Discuss the use of partial auxiliary views
    2. Discuss rules and conventions for hidden lines in auxiliary views
    3. Discuss auxiliary section views

CAD-D1-LE
Understand and Apply Mechanical Drawing Methods
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Choose the correct orthographically projected object given the isometric projection;
b) Choose the correct isometrically projected object given the orthographic projection;
c) Identify similar edges and surfaces between multiple views of an orthographically projected object;
d) Complete the orthographic view of an object given at least two other orthographic views;
e) Create a three-view orthographic projection of an object given the isometric projection; and,
f) Answer review questions.

CAD-D2-HO
Create Detail Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand and apply detail drawing methods;
b. Identify types of detail drawings;
c. Understand layout of detail drawings;
d. Identify individual parts for detailing;
e. Understand role of the manufacturing process in the detail drawings; and,
f. Identify part dimensions from drawings.

Module Outline:

I. Define ***Detail Drawing:*** Drawing Which Supplies Information for the Manufacture of an Individual Part
II. Discuss Need for Detail Drawing
  A. Discuss shape description (drawing geometry) for individual parts
    1. Discuss proper view selection
    2. Discuss proper view type (section, auxiliary, etc.)
  B. Discuss size description (dimensions) for individual parts
    1. Discuss influence of manufacturing process
    2. Include limits and tolerances
  C. Discuss specifications
    1. General notes
    2. Manufacturing notes
    3. Material specifications
III. Apply Limits and Tolerances to Detail Drawing
  A. Discuss application of geometric dimensioning and tolerancing (GD&T) for each type of manufacturing process
  B. Discuss application of dimensional limits and tolerancing for each type of manufacturing process
  C. Discuss application of appropriate fit specifications
  D. Where appropriate, check fit between mating parts
IV. Understand Standard Detail Drawing Guidelines for Each Manufacturing Processes
  A. Machining drawing
  B. Casting drawing
  C. Forging drawing
  D. Forming (sheet metal) drawing
  E. Welding drawing

CAD-D2-LE
Create Detail Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create a detail drawing of a specified part given information such as dimensions, manufacturing process, assembly parameters, and limits and fits. Detail drawing assignments should progress systematically by increasing the complexity in logical steps;

For example:

(1) The first assignment may focus on drawing with proper view selection and dimensions;

(2) The second assignment should include dimensional limits and fits; and,

(3) The next assignments should increase the difficulty further by adding GD&T specifications and incorporating manufacturing process information.

CAD-D3-HO
Create Assembly Drawings
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Identify types of assembly drawings;
- b. Understand and apply appropriate assembly drawing layout; and,
- c. Understand and apply assembly drawing practices.

Module Outline:

- I. Define ***Assembly Drawing:*** A Drawing Which Shows the Machine or Mechanism in its Assembled State
- II. Discuss Purpose of Assembly Drawing
    - A. Show machine or mechanism in assembled state
    - B. Show relationship of various parts to one another
    - C. Provide designation and documentation of each individual part
    - D. Provide overall size dimensions
        - 1. Capacity dimensions
        - 2. Range-of-motion dimensions
        - 3. Mating part dimensions
    - E. Show order of installation for specific parts
- III. Discuss Types of Assembly Drawings
    - A. Design assembly drawings
        - 1. Part of set of drawings comprising detail drawings of individual parts and assembly drawing.
        - 2. Types:
            - a. Orthographic assembly drawing - standard multiview or exploded view
            - b. Pictorial assembly drawing (isometric or oblique) - standard or exploded view
            - c. Sub-assembly drawing - orthographic or pictorial (same as master assembly drawing)
    - B. Installation assembly drawings
        - 1. Assembly drawing which graphically shows order of assembly
        - 2. Exploded orthographic or pictorial drawing
    - C. Catalog assembly drawings
        - 1. Used to graphically describe machine or mechanism for cataloging purposes
        - 2. Provides dimensions critical to design specification
        - 3. Shows object in operating configuration
        - 4. Orthographic or pictorial drawing (unexploded)

- IV. Discuss Standard Rules for Assembly Drawings
  - A. Discuss view selection
    - 1. Include orthographic (regular and auxiliary) and partial views
    - 2. Views must show assembly in proper operating configuration
    - 3. Should focus on function of assembly not the description of individual shapes of parts
    - 4. Use the minimum number of views/partial views necessary to describe assembly
  - B. Discuss use of section views
    - 1. Hidden lines typically omitted unless needed for clarity
    - 2. Section views often required to show interior parts/detail
  - C. Discuss application of dimensions
    - 1. Size description of individual part is unnecessary in the assembly drawing
    - 2. Dimensions generally omitted in assembly drawings
      - a. Special case: detail assembly drawing
        - (1) Drawing combines the detail description (size and shape) of individual parts with the assembly drawing
        - (2) Restricted to simple assemblies
        - (3) Corresponding separate detail drawings of parts unnecessary
    - 3. If needed, typical dimensions consist of:
      - a. Overall size of assembled unit
      - b. Dimensions used to provide description for parts mating to assembled unit
      - c. Indicate maximum/minimum ranges-of-motion of special features of assembled unit
      - d. Post-assembly operation is required (e.g., machining)
  - D. Discuss practice of part identification
    - 1. Individual parts are identified with part numbers inside balloons attached to leaders
      - a. Leaders never cross
      - b. Balloons arranged in rows or columns on drawing
    - 2. Each part must have a part number
    - 3. Identical parts use same part number
    - 4. Parts are listed in the bill of materials (BOM) also known as a parts list (see Module CAD-D5: Create Bill of Materials/Parts List)
  - E. Discuss miscellaneous rules and guidelines
    - 1. Use phantom lines for features drawn showing range-of-motion
    - 2. Discuss alternate methods for identifying part numbers
    - 3. Discuss application of assembly drawing and detail drawings on same drawing sheet

CAD-D3-LE
Create Assembly Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create an assembly drawing given the detail. The detail drawings could have been completed in a previous assignment or from another source. If time permits, multiple assembly drawings should be drawn using progressively more difficult drawings. Include orthographic, exploded and detail assembly drawings.

CAD-D4-HO
Perform Technical Lettering
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand technical lettering styles;
- b. Identify and apply technical lettering styles; and,
- c. Identify and apply standard notations.

Module Outline:

- I. Discuss Lettering Style for Mechanical Drawings
  - A. Gothic sans-serif (lit. Gothic without serifs)
  - B. Standard height = 1/8 inch (3 mm)
  - C. Use all capital letters
  - D. Vertical or italic (inclined to right) letters
- II. Lettering Technique
  - A. Using straight-edge aids
    - 1. Using the T-square and triangle
    - 2. Using the Ames Lettering Guide
  - B. Demonstrate proper construction techniques
    - 1. Follow prescribed guidelines for each letter
    - 2. Follow prescribed guidelines for each number
  - C. Demonstrate proper spacing
    - 1. Spacing between letters
    - 2. Spacing between words
    - 3. Spacing between lines of text

CAD-D4-LE
Perform Technical Lettering
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Use the technical lettering style to write the alphanumeric series, repeating each letter/number 2-5 times (use standard letter height and style);
b) Use the technical lettering style to write common drawing notes (general and local); and,
c) Answer review questions.

CAD-D5-HO
Create Bill of Materials/Parts List
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify components included in bill of material/parts list;
b. Identify commercially available components in assembly;
c. Identify non-commercially available components in assembly; and,
d. Understand format of a bill of material/parts list.

Module Outline:

I. Identify Need for Bill of Material (BOM)
    A. Discuss usage on assembly drawings
    B. Discuss correlation with detail drawings
    C. Discuss correlation with parts not represented by detail drawings (purchased parts)
II. Understand Format of a BOM
    A. Discuss location on drawing (including as a separate page)
    B. Discuss typical dimensions/sizes for BOM
    C. Discuss part description (part number, description, number required, etc.)

CAD-D5-LE
Create Bill of Materials/Parts List
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Use CAD to draw various styles of parts lists and add given parts data (see the recommended textbooks/references for various parts list styles); and,

b) Add a parts list to an assembly drawing.

CAD-D6-HO
Apply Dimensions and Notes
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify dimensioning systems;
b. Understand and apply current dimensioning standards;
c. Understand dimensioning terminology; and,
d. Understand and apply dimensioning strategy.

Module Outline:

I. Identify Dimensioning Systems
  A. Decimal-inch system
    1. Standard units: inches
    2. Proper number of decimal places
    3. Handling of leading and trailing zeros
  B. SI (metric) system
    1. Standard units: millimeters
    2. Proper number of decimal places
    3. Handling of leading and trailing zeros
II. Understand and Apply Current Dimensioning Standards
  A. Discuss ANSI Y14.5M dimensioning standards
  B. Discuss ISO dimensioning standards
III. Understand Dimensioning Terminology
  A. Discuss elements of a dimension
    1. Extension lines
    2. Dimension line
    3. Arrowheads
    4. Leaders
    5. Dimension text (number)
    6. General and local notes
    7. Center marks
IV. Understand and Apply Dimensioning Strategy
  A. Understand need for dimensions:
    1. Orthographic views of object provides accurate shape description
    2. Dimensioning needed to provide accurate size description
  B. Considerations while dimensioning:
    1. Consider finished object
    2. Consider production process(es) used to fabricate object
    3. Consider function of object

C. **Dimension in two steps:**
   1. **Dimension the SIZE of features**
   2. **Dimension the LOCATION of features with respect to each other**

D. **Apply dimensions according to the basic geometric shape of the features**
   1. **Show dimensions for rectangular prism**
   2. **Show dimensions for cylinder**
   3. **Show dimensions for hole ("negative" cylinder)**
   4. **Show dimensions for cone**
   5. **Show dimensions for pyramid**
   6. **Show dimensions for sphere (rarely used)**
   7. **Show dimensions for torus (rarely used)**

E. Apply general guidelines while dimensioning:
   1. Dimensions should be convenient for assembly, fabrication, and inspection
   2. No scaling of dimensions
   3. No assumed dimensions
   4. No dimensions to inaccessible features
   5. No redundant or superfluous dimensions

F. Place dimensions properly according to logical and practical layout
   1. Locate center marks with dimensions
   2. Place dimensions on outside of object
   3. Apply *contour rule:* dimension in view where feature is shown in profile
   4. Establish and use datum surfaces
   5. Dimension the diameter of holes in their circular view
   6. Dimension the diameter of cylinders in their rectangular view
   7. Do not dimension to hidden lines/features
   8. Do not cross dimension lines
   9. Apply leaders radially
   10. Group notes above title block
   11. Use standard symbology for dimensions

CAD-D6-LE
Apply Dimensions and Notes
Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Dimension previously created orthographic drawings, starting with simple objects and progressing to more complex shapes;

b) Create orthographic representations of objects complete with dimensions; and,

c) Answer review questions.

CAD-D7-HO
Apply Dimensional Limits and Tolerances
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand tolerancing practices;
- b. Identify types of tolerances;
- c. Apply tolerances to features;
- d. Compute tolerance ranges;
- e. Understand inch fit system;
- f. Understand metric fit system;
- g. Apply fit specifications to features;
- h. Compute fits from tabular data and vice versa; and,
- i. Identify types of fits.

Module Outline:

- I. Discuss the Need and Purpose for Dimensional Limits
  - A. History of engineering dimensioning and manufacturing
    - 1. Before mass production (Henry Ford's assembly line) each part was manufactured as a unique entity
    - 2. Mass production required that all parts in a machine must be manufactured and assembled accurately and quickly, with little variation between batches
  - B. Inherent inaccuracy in manufacturing operations
    - 1. Measuring with 100% accuracy is impossible
    - 2. Cutting, grinding, forming, etc., with 100% accuracy is impossible
  - C. Mass production techniques
    - 1. Identical parts manufactured on the same machine will have dimensional variations
    - 2. Knowledge of permissible/allowable size variations will allow for better product control
  - D. Part interchangeability
- II. Limits and Tolerances
  - A. Define ***limits*** - permissible variations in the specified form, size, or location of individual features of a part from that shown on the drawing
  - B. Define ***tolerances*** - largest and smallest permissible sizes
  - C. Define other key concepts:
    - 1. Actual size
    - 2. Basic size

  - 3. Design size
  - 4. Limits of size
  - 5. Nominal size
  - 6. Maximum material condition
- D. Discuss tolerance type and format
  - 1. Bilateral tolerance
  - 2. Unilateral tolerance
  - 3. Equal and unequal tolerances
- E. Discuss tolerance dimensions
  - 1. Limit dimensions
    - a. When are limit dimensions used and why
    - b. Show limit dimensions applied to circular features and rectangular features
  - 2. Plus/minus (±) tolerancing dimensions
    - a. When are plus/minus tolerance dimensions used and why
    - b. Show plus/minus tolerance dimensions applied to circular features and rectangular features
  - 3. General tolerance notes
  - 4. Dimensional units
    - a. Metric tolerances
    - b. Inch tolerances
  - 5. Tolerance accumulation
    - a. Continuous (chain) dimensions
    - b. Baseline (datum) dimensions
    - c. Direct dimensions

III. Fits and Allowances

- A. Define *fit* - relationship between two mating parts with respect to the amount of clearance or interference present when they are assembled
- B. Discuss types of fits
  - 1. Clearance fits
  - 2. Interference fits
  - 3. Transitions fits
- C. Define other key concepts:
  - 1. Basic size
  - 2. Deviation
    - a. Upper deviation
    - b. Lower deviation
  - 3. Tolerance zone
  - 4. Fundamental deviation
- D. Discuss standard inch fits
  - 1. Discuss which fits correspond to specific manufacturing operations
  - 2. Discuss which fits correspond to specific assembly operations
  - 3. Types of inch fits:

      a. Running and sliding fits (RC1 to RC9)
      b. Locational clearance fits (LC1 to LC11)
      c. Locational transition fits (LT1 to LT6)
      d. Locational interference fits (LN1 to LN6)
      e. Force or shrink fits (FN1 to FN5)
   4. Discuss basic hole system
      a. Demonstrate how to find fit values in appropriate tables
      b. Show calculations to determine proper fit specifications
   5. Discuss basic shaft system
      a. Demonstrate how to find fit values in appropriate tables
      b. Show calculations to determine proper fit specifications
   6. Show proper format for dimensioning inch fits

E. Discuss standard metric fits
   1. Discuss which fits correspond to specific manufacturing operations
   2. Discuss which fits correspond to specific assembly operations
   3. Discuss metric tolerance grades
      a. Discuss application of tolerance grades to various manufacturing operations
      b. Discuss metric fit codes based on tolerance grades
   4. Discuss basic hole system
      a. Demonstrate how to find fit values in appropriate tables
      b. Show calculations to determine proper fit specifications
   5. Discuss basic shaft system
      a. Demonstrate how to find fit values in appropriate tables
      b. Show calculations to determine proper fit specifications
   6. Show proper format for dimensioning metric fits

CAD-D7-LE
Apply Dimensional Limits and Tolerances
Attachment 2: MASTER Laboratory Exercise

Students will be given homework assignments in which they must:

a) Compute limit dimensions and tolerances given fit specifications; and,

b) Determine fit specifications given application and dimensional information.

Students will be given drawing assignments in which they must perform the above computations and:

a) Make the appropriate detail drawings of the specified part with limit dimensions and fits specifications; and,

b) Create drawings of assembled parts with proper fits between mating parts.

CAD-D8-HO
Apply Current Drafting Standards to Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand relevant standards;
- b. Identify sources of standards;
- c. Reference standards; and,
- d. Apply relevant standards.

Module Outline:

- I. Purpose of Standards
  - A. Create universal language
  - B. Provide rules and guidelines
  - C. Detail methods and procedures
- II. Types of Standards
  - A. Industry
    - 1. ANSI – American National Standards Institute
      - a. Uses English system of units (basic linear unit = inch)
      - b. Used by most companies dealing with mechanical design and drafting in the United States
      - c. Many standards developed in conjunction with the American Society of Mechanical Engineers (ASME) and the Society of Automotive Engineers (SAE)
    - 2. ISO – International Standards Organization
      - a. Uses SI (metric) system of units (basic linear unit = millimeter)
      - b. Used by most companies dealing with mechanical design and drafting throughout Europe and Asia
  - B. Company
    - 1. Specific to the company and/or department
    - 2. Usually a modification of the ANSI or ISO standards
    - 3. Acts to establish and maintain a consistency within the company
- III. ANSI Standards Relevant to Mechanical Design and Drafting
  - A. ANSI produces hundreds of standards relevant to mechanical design and drafting
  - B. Short list of relevant areas of standardization
    - 1. Drafting
    - 2. Dimensioning and Surface Finish
    - 3. Graphic Symbols

    4. Bolts, Screws, and Nuts
    5. Gears
    6. Keys and Pins
    7. Piping
    8. Rivets
    9. Threads
    10. Washers

C. Main Standards
    1. Dimensioning and Tolerancing, ANSI/ASME Y14.5M-1994
    2. Multiview and Sectional View Drawings, ANSI/ASME Y14.3M-1994
    3. Engineering Drawings, Types, and Applications, ANSI/ASME Y14.24M-1989
    4. Mechanical Assemblies, ANSI/ASME Y14.14

D. Other Often Used ANSI Standards
    1. Preferred Limits and Fits for Cylindrical Parts, ANSI B4.1-1967 (R1994)
    2. General Tolerances for Metric Dimensioned Products, ANSI B4.3-1978 (R1994)
    3. Preferred Metric Limits and Fits, ANSI B4.2-1978 (R1994)
    4. Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
    5. Gear and Spline Drawing Standards – Part 1, for Spur, Helical, Double Helical, and Rack, ANSI/ASME Y14.7.1-1971 (R1993)
    6. Gear and Spline Drawing Standards – Part 2, Bevel and Hypoid Gears, ANSI/ASME Y14.7.2-1978 (R1994)
    7. Parts Lists, Data Lists, and Index Lists, ANSI/ASME Y14.34M-1990
    8. Screw Thread Representation, ANSI/ASME Y14.6-1978 (R1993)
    9. Screw Thread Representation, Metric, ANSI/ASME Y14.6aM-1981 (R1993)

CAD-D8-LE

Apply Current Drafting Standards to Drawings

Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Identify standards organizations;

b) Discuss the purpose of standards in the mechanical design and drafting field; and,

c) Identify which standards would be appropriate for specific drafting assignments.

CAD-D9-HO
Perform Drawing Revisions
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Understand reason for revision;
- b. Apply revision notation; and,
- c. Complete revision documentation.

Module Outline:

- I. Purpose of Revisions
  - A. Define revision: a change or modification made to a design which is reflected in the engineering drawings
  - B. Standard: Revisions of Engineering Drawings, ANSI/ASME Y14.35-1992
  - C. Common types of revisions
    - 1. Changes in design
    - 2. Changes in material
    - 3. Changes in manufacturing processes/tooling
    - 4. Fixing errors in drawing
    - 5. Changes in dimensions
    - 6. Change in customer requirements
- II. Procedure
  - A. Change made directly to drawing
  - B. Remove original item, replace with change or modification
  - C. A balloon and number are placed adjacent to revision
  - D. Description of revision is made in the revision block
- III. Revision Block
  - A. Block size similar to title block or parts list
  - B. Areas for revision number, revision explanation, date, and signature of checker
    - 1. Revision number corresponds to balloon number
    - 2. Description should include information from original item (before revision)
    - 3. Zone numbers may be used in place of balloon numbers
  - C. Allowance made for future revisions

CAD-D9-LE
Perform Drawing Revisions
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Describe the process of making revisions, including definition and required components; and,

b) Make revisions to an existing drawing.

CAD-D10-HO
Use Commercial and Vendor Data
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand commercial supplier catalogs; and,
b. Understand vendor drawings.

Module Outline:

I. Describe Vendor Catalogs: Catalogs of Purchased Parts Typically Used in the Design of Mechanical Parts
II. Discuss Standard Parts Which Are Purchased Using Vendor Catalogs
    A. Fasteners
        1. Threaded (English and metric) (including washers and nuts)
        2. Non-threaded (retaining rings, pins, etc.)
    B. Bearings and bushings
    C. Gears
    D. Belt drives
    E. Chain drives
    F. Miscellaneous parts
        1. Couplings
        2. Cams
III. Discuss Types of Catalogs
    A. Catalogs from the manufacturer of the specific part (e.g., Waldes Tru-Arc Snap Rings, Boston Gear Works, American Drill Bushing Co., SKF Bearings)
    B. Catalogs from a supply shop carrying many different types of mechanical parts (e.g., McMaster-Carr, W.W. Grainger)
IV. Discuss How to Use Catalogs
    A. Must have specification data such as shaft size, housing diameter, material thickness, material type, conditions of usage, load, speed, etc.
    B. Specifications vary according to the type of part desired and its use
    C. Parts used in conjunction with shafts are typically specified by the shaft diameter

CAD-D10-LE
Use Commercial and Vendor Data
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN **.... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.**

	Duties	Tasks												
A	Apply Mathematical Concepts	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	Demonstrate Fundamental Drafting Skills	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	Plan and Organize Activities	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	Prepare Mechanical Production Drawings	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/ parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	Assist Engineering Personnel	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	Use Computer-Aided Drafting System	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

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CAD-E1-HO
Understand Basic Design Procedures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify design process; and,
b. Discuss application of design methods.

Module Outline:

- I. Define Machine Design: Application of Science and Technology to Devise New or Improved Products for the Purpose of Satisfying Human Needs
    - A. Discuss types of needs
        - 1. Well-defined needs
        - 2. Vague needs
- II. Discuss Phases of Design
    - A. List and discuss the phases of the design process
        - 1. Recognition of Need
            - a. Creative phase
            - b. Triggered by various circumstances
            - c. Distinctly different from "Definition of Problem"
        - 2. Definition of Problem
            - a. Must include all specifications for machine or mechanism
            - b. Specifications include cost range, weight range, life range, reliability, characteristics, dimensions, limitations, operating conditions, etc.
        - 3. Synthesis
            - a. Optimum solution is synthesized
            - b. Iterative process involving "Analysis and Optimization" phase
        - 4. Analysis and Optimization
            - a. Design is tested
            - b. Testing is done through mathematical modeling
        - 5. Evaluation
            - a. Prototype is tested under real-world conditions
            - b. The next phase of testing after "Analysis and Optimization"
            - c. Some factors to consider during testing:
                - (1) Strength
                - (2) Reliability
                - (3) Thermal considerations
                - (4) Corrosion

            - (5) Wear
            - (6) Friction
            - (7) Cost
            - (8) Safety
            - (9) Weight
            - (10) Noise
            - (11) Control
            - (12) Stiffness
            - (13) Lubrication
            - (14) Maintenance
        - 6. Presentation of Results
    - B. Discuss the order of phases in the design process
    - C. Discuss feedback loops and iterative steps and how they are essential to the design process
    - D. Discuss other examples of the design process
- III. Discuss Design Methods
    - A. Discuss principles of Design For Manufacturing (DFM)
    - B. Discuss principles of Reverse Engineering
    - C. Discuss principles of Design For Assembly (DFA)
- IV. Discuss Knowledge Relevant to Machine Design
    - A. Mechanical drawing
    - B. Kinematics
    - C. Mechanics
    - D. Materials engineering
    - E. Strength of materials
    - F. Manufacturing processes
    - G. Thermodynamics
    - H. Fluid dynamics

CAD-E1-HO
Understand Basic Design Procedures
Attachment 1: **MASTER** Handout

Students will be given classwork and homework assignments in which they must:

a) **Answer review questions; and,**

b) **Given appropriate specifications, students select correct item from a parts catalog and record additional information which could be used in the drawing of the assembly.**

Utilize Fasteners for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Select appropriate fasteners and springs for application;
b. Understand basic fasteners and spring analysis;
c. Identify types of fasteners and springs; and,
d. Use supplier catalogs and standard references to select fasteners and springs for mechanical application.

Module Outline:

I. Discuss Threaded Fasteners
  A. Discuss features of threaded fasteners
    1. Discuss thread form
    2. Discuss thread terminology
  B. Discuss fastener types: bolts, screws, nuts, set screws
  C. Discuss graphical representation of threads
    1. Demonstrate detailed representation
    2. Demonstrate schematic representation
    3. Demonstrate simplified representation
  D. Demonstrate the procedure for representing internal threads (tapped holes)
  E. Demonstrate the procedure for representing external threads (screws, bolts, etc.)
  F. Discuss thread symbology for dimensioning
  G. Discuss use of threaded fasteners
    1. Demonstrate assembly techniques with fasteners
    2. Compute load analysis for fasteners
      a. Compute force loading
      b. Determine bolt patterns

II. Discuss Non-Threaded Fasteners
  A. Discuss common types of non-threaded fasteners:
    1. Retaining rings (also known as "snap rings"): prevent relative axial motion between a shaft and a hub
      a. Internal retaining rings: ring fits into a groove cut into the surface of a hole in a hub
      b. External retaining rings: ring fits into a groove cut into the surface of a shaft
      c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.

- d. Discuss method of representation on drawings
  - (1) Notations
  - (2) Dimensions
  - (3) Graphical representation – shaft, hole, and retaining ring
- 2. Keys: prevent relative rotational motion between a shaft and a hub
  - a. Discuss types of keys: square, flat, Gib-head, Pratt & Whitney, Woodruff
  - b. Discuss necessary features for using keys – keyway in hub, keyseat in shaft (shaped for each type of key)
  - c. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
  - d. Compute loading on key, shaft, and hub
  - e. Discuss method of representation on drawings
    - (1) Notation
    - (2) Dimensions
    - (3) Graphical representation – keyseat, keyway, key
- 3. Pins: prevent relative axial and rotation motion between a shaft and a hub
  - a. Discuss types of pins – semi-permanent, quick-release
    - (1) Machine pins: dowel pins, taper pins, clevis pins, cotter pins
    - (2) Radial locking pins
    - (3) Grooved straight pins
    - (4) Spring pins
    - (5) Quick-release pins: push-pull pins, positive locking pins
  - b. Discuss method of selection from supplier catalogs: size of shaft/hole, loading conditions, etc.
  - c. Compute loading on pin, shaft, hub
  - d. Discuss method of representation on drawings
    - (1) Notation
    - (2) Dimensions
    - (3) Graphical representation
- 4. Discuss briefly other types of non-threaded fasteners: rivets, splines/serrations, knurled joints, adhesives, clips, etc.

B. Discuss springs
- 1. Discuss types of springs: compression, extension, flat, and torsion springs
- 2. Discuss application of springs
- 3. Discuss method of selection from supplier catalogs
- 4. Discuss methods of representation on drawings
  - a) Notation
  - b) Dimensions

    c) **Graphical representation**

5. **Compute design parameters: deflection, stress, loading, etc.**

CAD-E2-LE
Utilize Fasteners for Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) **Answer review questions; and,**

b) **Given design application with loading parameters, select specified fastener. Students should complete 3-5 problems for each type of fastener listed above.**

CAD-E3-HO
Utilize Power Transmission Elements for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:

- a. Select appropriate power transmission elements for application;
- b. Understand basic power transmission element analysis;
- c. Identify types of power transmission elements; and,
- d. Use supplier catalogs and standard references to select power transmission elements for mechanical applications.

Module Outline:

- I. Define "Power Transmission Element": Machine Element Used in the Transmission of Power from One Location to Another
- II. Discuss Gear Drives
  - A. Discuss gear terminology
  - B. Discuss spur gears
    - 1. Discuss method of representation on drawings
      - a. Notation
      - b. Dimensions
      - c. Graphical representation
        - (1) Detail drawings
        - (2) Assembly drawings
    - 2. Design spur gear drive systems
      - a. Compute power-transmitting capacity
      - b. Select drive components from supplier catalogs
      - c. Determine assembly methods for drive system components
  - C. Discuss rack and pinion gears
    - 1. Discuss method of representation on drawings
      - a. Notation
      - b. Dimensions
      - c. Graphical representation
        - (1) Detail drawings
        - (2) Assembly drawings
    - 2. Design rack and pinion gear drive systems
      - a. Compute power-transmitting capacity
      - b. Select drive components from supplier catalogs
      - c. Determine assembly methods for drive system components
  - D. Discuss bevel gears

1. Discuss method of representation on drawings
   a. Notation
   b. Dimensions
   c. Graphical representation
      (1) Detail drawings
      (2) Assembly drawings
2. Design bevel gear drive systems
   a. Compute power-transmitting capacity
   b. Select drive components from supplier catalogs
   c. Determine assembly methods for drive system components

E. Discuss worm and worm gears
   1. Discuss method of representation on drawings
      a. Notation
      b. Dimensions
      c. Graphical representation
         (1) Detail drawings
         (2) Assembly drawings
   2. Design worm gear drive systems
      a. Compute power-transmitting capacity
      b. Select drive components from supplier catalogs
      c. Determine assembly methods for drive system components

III. Discuss Belt Drives
   A. Discuss belt drive terminology
   B. Discuss flat belts
      1. Discuss method of representation on drawings
         a. Notation
         b. Dimensions
         c. Graphical representation
      2. Design flat belt drive systems
         a. Compute power-transmitting capacity
         b. Select drive components from supplier catalogs
         c. Determine assembly methods for drive system components
   C. Discuss V-belts
      1. Discuss method of representation on drawings
         a. Notation
         b. Dimensions
         c. Graphical representation
      2. Design V-belt drive systems
         a. Compute power-transmitting capacity
         b. Select drive components from supplier catalogs
         c. Determine assembly methods for drive system components

IV. Discuss Chain Drives
  A. Discuss chain drive terminology
  B. Discuss basic types of chains: detachable, pintle, offset-sidebar, roller, double-pitch, inverted-tooth silent, bead (slider)
  C. Discuss sprockets
  D. Design roller chain drives
    1. Compute power-transmitting capacity
    2. Select drive components from supplier catalogs
    3. Determine assembly methods for drive system components
  E. Discuss method of representation on drawings
    1. Notation
    2. Dimensions
    3. Graphical representation

V. Discuss Couplings
  A. Define coupling: mechanical device used to connect two shafts.
  B. Discuss types of couplings
    1. Solid coupling
    2. Flexible coupling
    3. Universal coupling
    4. Flexible shafts
  C. Discuss application parameters: shaft alignment, operating conditions, dynamic forces, etc.
  D. Compute required strength capacity
  E. Select coupling components from supplier catalogs
  F. Determine assembly methods for coupling system components

VI. Discuss Cams
  A. Discuss cam terminology
  B. Discuss cam applications
  C. Discuss types of cam configurations
    1. Discuss plate cams
    2. Discuss translation cams
    3. Discuss positive-motion cams
    4. Discuss cylindrical cams
  D. Discuss types of cam motions
    1. Discuss uniform motion (constant velocity)
      a. Compute motion characteristics
      b. Design cam displacement diagram
    2. Discuss parabolic motion
      a. Compute motion characteristics
      b. Design cam displacement diagram
    3. Discuss harmonic motion
      a. Compute motion characteristics
      b. Design cam displacement diagram
    4. Discuss cycloidal motion
      a. Compute motion characteristics

        - b. Design cam displacement diagram
    - 5. Discuss other motion types: modified trapezoidal motion, modified sine-curve motion
        - a. Compute motion characteristics
        - b. Design cam displacement diagram
- E. Design cam drive systems
    - 1. Compute power-transmitting capacity
    - 2. Select drive components from supplier catalogs
    - 3. Determine assembly methods for drive system components
- F. Discuss method of representing cams on drawings
    - 1. Notation
    - 2. Dimensions
    - 3. Graphical representation
        - a. Detail drawings
        - b. Assembly drawings

CAD-E3-LE
Utilize Power Transmission Elements for Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Select appropriate components given necessary system specifications (include all necessary drawings, i.e., detail drawings and assembly drawings with full dimensions; show all computations):
   (1) Gear drives systems;
   (2) Chain drives systems;
   (3) Belt drives systems; and,
   (4) Cam systems.

CAD-E4-HO
Utilize Bearings For Mechanical Applications
Attachment 1: MASTER Handout

Objective(s)

Upon completion of this unit the student will be able to:
a. Identify types of bearing devices;
b. Understand basic bearing device analysis;
c. Select appropriate bearing devices for application; and,
d. Use supplier catalogs and standard references to select bearing devices for mechanical applications.

Module Outline:

I. Define "Bearing:" Device Used to Permit Smooth, Low Friction Motion Between Two Surfaces
II. Discuss Major Types of Bearings
  A. Plain bearings
    1. Journal (sleeve) bearings
    2. Thrust bearings
  B. Ball bearings
    1. Radial bearings
    2. Thrust bearings
  C. Roller bearings
    1. Cylindrical bearings
    2. Needle bearings
    3. Tapered bearings
    4. Spherical bearings
III. Discuss Typical Applications of Bearings
  A. Radial loads
  B. Thrust loads
  C. Combination loads
IV. Compute Operating Conditions (In the Following Order)
  A. Compute life of bearings - use life-expectancy curves (from bearing supplier)
  B. Compute load on bearings
    1. Compute static load
    2. Compute dynamic load
  C. Compute speed (rpm) of shaft
V. Select Appropriate Bearing Based on Operating Conditions (see IV. A, B, C above)
VI. Determine Fit Specifications Between Bearing and Mating Parts (Shaft, Housing, Etc.) (From Bearing Supplier)

VII. Discuss the Required Drawings for a Bearing Assembly
   A. Draw shaft detail drawing with tolerance dimensions
   B. Draw housing detail drawing with tolerance dimensions
   C. Draw assembly drawing showing bearings, shaft and housing

CAD-E4-LE
Utilize Bearings For Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Select proper bearings for a system given the operating conditions. Students must compute the life-load-speed characteristics of the system, then use bearing supplier catalogs to make a selection. A complete drawing set (shaft and housing detail, shaft/housing/bearing assembly) should also be included with full tolerance dimensions.

CAD-E5-HO
Understand Basic Manufacturing Methods
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of manufacturing operations;
b. Understand application of manufacturing in drafting and design of machinery; and,
c. Prepare drawings for manufacturing applications.

Module Outline:

I. Discuss Types of Manufacturing Operations
  A. Discuss Machining operations
    1. Define machining: Metal removal process using sharp tools. Produces flat, smooth (relatively) surface.
    2. Discuss types of machining operations
      a. End milling/face milling – rotating tool cuts surface of metal
      b. Machine lathe – tool is stationary (except for radial motion) and the workpiece (metal) rotates
      c. CNC machining – "computer-numerical control" machine tool is controlled by computer code detailing each successive cutting operation
    3. Discuss drafting considerations
      a. Discuss surface finish marks
      b. Discuss machining datum surfaces
      c. Discuss shape of surface after machining
        (1) Tool creates sharp edges and corners
        (2) Interior corner radius limited by geometry of tool
        (3) Surfaces are flat
  B. Discuss metal casting
    1. Define casting: production of parts by pouring molten metal into a mold.
    2. Discuss types of casting operations
      a. Sand mold casting
      b. Shell mold casting
      c. Plaster mold casting
      d. Permanent mold casting
      e. Investment mold casting
      f. Full mold casting

        - g. Centrifugal casting
        - h. Continuous casting
        - i. Die casting
    - 3. Discuss design considerations
        - a. Discuss metal solidification in castings
        - b. Discuss casting design rules
    - 4. Discuss drafting practices
        - a. Discuss the casting drawing
        - b. Discuss casting tolerances
        - c. Discuss machining allowances and tolerances
        - d. Discuss draft angles
        - e. Discuss parting lines
        - f. Discuss casting datums
- C. Discuss forging operations
    - 1. Define forging: plastically deforming a heated piece of metal into a predetermined shape using a specially shaped press.
    - 2. Discuss forging design and drafting considerations
        - a. Discuss the forging drawing
        - b. Discuss forging tolerances
        - c. Discuss machining allowances and tolerances
        - d. Discuss draft angles
        - e. Discuss parting lines
        - f. Discuss forging datums

CAD-E5-LE
Understand Basic Manufacturing Methods
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions

b) Create a casting drawing and detail (machining) drawing based on given design specifications. Include all necessary casting tolerances and datums.

c) Create a forging drawing and detail (machining) drawing based on given design specifications. Include all necessary forging tolerances and datums.

CAD-E6-HO
Utilize Brakes and Clutches for Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify types of brakes and clutches;
b. Understand basic brake and clutch analysis; and,
c. Select appropriate brakes and clutches for application.

Module Outline:

I. Discuss brakes
    A. Discuss brake terminology
    B. Discuss brake analysis
        1. Compute force-moment analysis
        2. Create free-body diagram
        3. Discuss frictional considerations
        4. Discuss thermal considerations
    C. Discuss types of brakes
        1. Discuss block brakes
        2. Discuss band brakes
        3. Discuss drum brakes
        4. Discuss caliper brakes
        5. Discuss disc brakes
    D. Discuss design considerations
        1. Compute brake parameters based on design analysis
        2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis
II. Discuss clutches
    A. Discuss clutch terminology
    B. Discuss clutch analysis
        1. Compute force-moment analysis
        2. Create free-body diagram
        3. Compute torque capacity
        4. Discuss frictional considerations
        5. Discuss thermal considerations
    C. Discuss types of clutches
        1. Discuss jaw clutches
        2. Discuss plate clutches
        3. Discuss cone clutches
        4. Discuss spring clutches
        5. Discuss over-running clutches

    6. Discuss electric clutches
    7. Discuss dry fluid clutches

D. Discuss design considerations
    1. Compute clutch parameters based on design analysis
    2. Demonstrate the procedure for selecting brakes from supplier catalogs based on design analysis

CAD-E6-LE
Utilize Brakes and Clutches for Mechanical Applications
Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Select appropriate brake and brake components given necessary system specifications. Show all computations. Prepare an assembly drawing of system; and,

c) Select appropriate clutch and clutch components given necessary system specifications. Show all computations. Prepare an assembly drawing of system.

CAD-E7-HO
Design Shafts For Use in Mechanical Applications
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Understand basic shaft analysis;
b. Select appropriate shafts for applications; and,
c. Use shafts in the design.

Module Outline:

I. Define Shaft: Rotating Cylindrical Member Designed to Transmit Torque
    A. Define axle: non-rotating shaft
II. Discuss Terminology: Torque, Moment, Power, Stress, Shear Stress, Stress Types
III. Discuss Standard Shafting
    A. Discuss standard materials
    B. Discuss production of shafts
    C. Discuss machining of shafts
IV. Discuss shaft analysis
    A. Discuss deflection of shaft
        1. Define shaft deflection
        2. Discuss forces involved in shaft deflection
    B. Discuss torsion of shaft
        1. Define shaft torsion
        2. Discuss forces involved in shaft torsion
    C. Discuss shear
        1. Define shear
        2. Discuss forces involved in shaft shear
    D. Compute simple relationships
        1. Compute stress given shaft properties
        2. Compute power given shaft properties
        3. Compute torsional stress given shaft properties
        4. Compute critical speed given shaft properties
    E. Design shaft for torsional stiffness
        1. Compute polar moment of inertia (J) (use tables)
        2. Compute torque (T) from operating conditions
        3. Compute Modulus of Rigidity (G) given shaft properties
        4. Compute angular deflection of shaft (θ) using T, G, J and shaft length (l)
        5. Compute minimum shaft diameter using T, G, θ, and shaft properties

        6. Select shaft based on minimum diameter requirement
    F. Design shaft for bending stiffness
        1. Create loading diagram (free-body diagram)
        2. Compute force-moment-torque values
        3. Compute Modulus of Elasticity (E)
        4. Compute Moment of Inertia (I)
        5. Compute maximum bending moment (use tables)
        6. Use the Principle of Superposition to find deflection values
        7. Create shear and moment diagrams
        8. Compute fatigue stress coefficients based on operating conditions and shaft properties
        9. Compute minimum diameter based on above calculations, operating conditions, and shaft properties.
    G. Design shaft for combined loading (torsion and bending)
        1. Demonstrate the procedure for using the Equivalent Torque Method
        2. Demonstrate the procedure for using the Equivalent Bending Moment Method
    H. Discuss the effects of keys, splines, and couplings on shafts
V. Demonstrate the Procedure for Creating a Detail Drawing of the Shaft
    A. Discuss standard methods for attaching machine elements to shafts (keys, splines, collars, taper fits, press fits, pins, retaining rings, etc.)
    B. Compute the fits and tolerances needed on the shaft
        1. Discuss fitting bearings
        2. Discuss fitting gears
        3. Discuss fitting keys, splines, other fasteners
        4. Discuss fitting other machine elements

CAD-E7-LE
Design Shafts For Use in Mechanical Applications
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Design a shaft given operating conditions and system requirements. Create a detail drawing with proper tolerances for all attached machine elements.

COMPUTER-AIDED DRAFTING AND DESIGN TECHNICIAN .... plans, lays out, and prepares engineering drawings, parts lists, diagrams, and related documents for layouts, sketches, and notes using manual or computer-aided techniques following current industry and company standards.

	Duties	← Tasks →												
A	**Apply Mathematical Concepts**	A-1 Perform basic arithmetic operations	A-2 Compute unit conversions	A-3 Perform basic trigonometric operations	A-4 Use the Cartesian coordinate system	A-5 Use the polar coordinate system								
B	**Demonstrate Fundamental Drafting Skills**	B-1 Use drawing media and related drafting materials	B-2 Use measuring scales	B-3 Identify drafting line styles and weights	B-4 Prepare title blocks and other drafting formats	B-5 Create technical sketches								
C	**Plan and Organize Activities**	C-1 Determine scope of drafting assignment	C-2 Select appropriate drafting techniques for drawings	C-3 Maintain supporting documents										
D	**Prepare Mechanical Production Drawings**	D-1 Understand and apply mechanical drawing methods	D-2 Create detail drawings	D-3 Create assembly drawings	D-4 Perform technical lettering	D-5 Create bill of materials/parts list	D-6 Apply dimensions and notes	D-7 Apply dimensional limits and tolerances	D-8 Apply current drafting standards to drawings	D-9 Perform drawing revisions	D-10 Use commercial and vendor data			
E	**Assist Engineering Personnel**	E-1 Understand basic design procedures	E-2 Utilize fasteners for mechanical applications	E-3 Utilize power transmission elements for mechanical applications	E-4 Utilize bearings for mechanical applications	E-5 Understand basic manufacturing methods	E-6 Utilize brakes and clutches for mechanical applications	E-7 Design shafts for use in mechanical applications						
F	**Use Computer-Aided Drafting System**	F-1 Start and exit a software program	F-2 Demonstrate proper file management techniques	F-3 Use directory structure	F-4 Open, save, and exit a drawing file	F-5 Utilize drawing setup procedures	F-6 Use geometric objects (e.g., lines, splices, circles, etc.)	F-7 Use text for drawing annotation	F-8 Use viewing/display commands	F-9 Control object properties	F-10 Understand procedure to print/plot a drawing	F-11 Use standard layering techniques	F-12 Create mechanical CAD drawings	F-13 Create 3D mechanical models
		F-14 Use drawing feature attributes	F-15 Obtain 3D model property data	F-16 Use CAD dimensioning features	F-17 Perform CAD customization procedures									

CAD-F1-HO
Start and Exit a Software Program
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Understand starting procedures; and,
- b. Understand exiting procedures.

Module Outline:

- I. Introduction to Computer Components
  - A. Introduce main components
    - 1. CPU and drive bays (3.5", 5.25", CD, etc.)
    - 2. Monitor
    - 3. Mouse/digitizer puck
    - 4. Keyboard
  - B. Introduce peripherals (if applicable)
    - 1. Printers/plotters
    - 2. Document scanners
    - 3. Digitizer
- II. Turn Computer (and Components) "On"
  - A. Locate and activate the POWER button on the computer or power supply
  - B. If necessary, locate and activate the POWER buttons on any additional components (monitor, printer, etc.)
    NOTE: Depending on the specific computer arrangement in the classroom the following may or may not apply.
  - C. Log onto the computer network
  - D. Start computer operating system (OS)
    NOTE: The presentation of the following topics will depend on the type of operating system and CAD software being used. The following sub-topics are general and may or may not apply in all cases.
- III. Start CAD (or Other) Program
  - A. Type the program executable file name (including directory paths) on the command line (DOS)
  - B. Double-click on the program icon (Windows 3.x, Windows 95, Windows NT)
- IV. Exit CAD (or Other) Program
- V. Turn Computer (and Components) "Off"
  - A. If applicable, exit OS (Windows 3.x, Windows 95, Windows NT)
  - B. If applicable, log out of network
  - C. Turn off the computer or power supply

D. Turn off any additional equipment

CAD-F1-LE

Start and Exit a Software Program

Attachment 2: MASTER Laboratory Exercise

Students must demonstrate the skills described above by performing the required steps to start a computer program beginning with the computer turned "off". Students should repeat these activities until the instructor is satisfied that the skills have been mastered.

CAD-F2-HO

Demonstrate Proper File Management Techniques

Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Explain file management techniques;
- b. Demonstrate file management procedures; and,
- c. Format a floppy disk.

Module Outline:

- I. Discuss Computer Directory Structure
  - A. Directory structure on a personal computer (PC)
    - 1. Hard drive - root and sub-directories
    - 2. Floppy drive
  - B. Directory structure on a computer network (user account only)
- II. Manage Directories
  - A. Create sub-directory from root directory
  - B. Create sub-directory from sub-directory
  - C. List files in directory
  - D. Delete sub-directories
- III. Manage Files
  - A. Copy file from directories on hard drive
  - B. Copy file from hard drive to floppy disk
  - C. Rename files
  - D. Delete file
- IV. Format Floppy Disk (With and Without System Files)

CAD-F2-LE
Demonstrate Proper File Management Techniques
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork assignments in which they must:

a) Create sub-directories on the hard drive (or in their user account on the network);
b) Format a floppy disk;
c) Create sub-directories on a floppy disk;
d) Copy files from directories on hard drive;
e) Copy files from hard drive to floppy disk (and vice versa);
f) Delete files; and,
g) Rename files.

CAD-F3-HO
Use Directory Structure
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify directories and sub-directories; and,
b. Create and delete directories.

Module Outline:

I. Define *Directory*: a Computer Directory, Also Referred to as a Sub-directory or Folder, Is an Area on the Computer Hard Disk Created by the User Which Is Set Aside to Store Specific Files. It Is Analogous to the File Folder System Used with Filing Cabinets, Where Each Computer Directory Represents a Separate File Folder and the Computer Files Correspond to the Papers Stored in the File Folders.

II. Using a File Viewing Program (such as Windows Explorer), Examine Directories/sub-directories on the Computer Hard Drive
   - A. Demonstrate the method for expanding the directory tree to show all sub-directories under a selected directory
   - B. Demonstrate the method for compacting the directory tree to hide all sub-directories under a selected directory

III. Using a File Viewing Program (such as Windows Explorer), Create a Sub-directory on the Computer Hard Drive
   - A. Discuss acceptable characters for use in directory names
   - B. Discuss acceptable length of directory names
   - C. Discuss case-sensitivity
   - D. Demonstrate the method for setting/changing properties of a directory
      1. Read-only
      2. Hidden
      3. Archive
   - E. Demonstrate procedure for renaming a directory

IV. Using a File Viewing Program (such as Windows Explorer), Copy And/or Move a File from One Directory into Another

V. Using a File Viewing Program (such as Windows Explorer), Delete a File from a Directory

VI. Using a File Viewing Program (such as Windows Explorer), Delete a Sub-directory on the Computer Hard Drive
   - A. Demonstrate procedure for deleting a single sub-directory
   - B. Demonstrate procedure for deleting a sub-directory and all directories under that sub-directories

CAD-F3-LE
Use Directory Structure
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Students should be given assignments in which they must create, rename, copy files into, and delete a sub-directory.

CAD-F4-HO
Open, Save, and Exit a Drawing File
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Create a new drawing file;
b. Open an existing drawing file;
c. Save a drawing file; and,
d. Exit and save a drawing file.

Module Outline:

I. Demonstrate Procedure for Starting the CAD Software
II. Demonstrate Procedure for Starting New CAD Drawing
    A. Use a previously created template when beginning a new drawing
    B. Create a new drawing without a template
III. Demonstrate Procedure for Opening Existing CAD Drawing
IV. Demonstrate Procedure for Saving Changes to the CAD Drawing
    A. Save with the current file name
    B. Save as a different file name (including directory location)
V. Demonstrate Procedure for Exiting the CAD Software
    A. Exit and save changes to CAD drawing
    B. Exit and save as another file name
    C. Quit the CAD drawing (exit and do not save changes to CAD drawing file)

CAD-F4-LE
Open, Save, and Exit a Drawing File
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,
b) Demonstrate skills necessary for achieving educational objectives.

CAD-F5-HO
Utilize Drawing Setup Procedures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify drawing setup procedures; and,
b. Perform drawing setup.

Module Outline:

I. Discuss Creation of Standard Layers for Mechanical Drawings
  A. Each layer used for specific linetype:
    1. Visible lines
    2. Hidden lines
    3. Center lines
    4. Phantom lines
    5. Dimension lines
    6. Extension lines
    7. Border line
    8. Construction line
    9. Section line
    10. Text
    11. Other miscellaneous linetypes used during drafting
  B. Each layer color controls the width of line during printing
II. Discuss the Selection and Loading of the Linetypes Necessary for Mechanical Drawing
III. Discuss the Inclusion of Internal Blocks Which May Be Used for the Following Purposes:
  A. Borders (inch and metric sizes)
  B. Title strips of various sizes (inch and metric sizes)
  C. Revision blocks (corresponding to the various border sizes)
  D. Bills of material (corresponding to the various border sizes)
  E. Tolerance blocks (corresponding to the various border sizes)
  F. Special symbols such as
    1. Mechanical parts
    2. Electrical symbols
    3. Dimension symbols
    4. Welding symbols
    5. HVAC symbols
IV. Discuss Screen Setup Procedures

- A. Discuss procedure for setting the screen color including the command line area and drawing area
- B. Discuss the procedure for setting the properties of the cursor/crosshair
  1. Discuss the procedure for setting the size of the cursor/crosshair
  2. Discuss the procedure for selecting the style of cursor/crosshair
  3. Discuss the procedure for setting the color of the cursor/crosshair
- C. Discuss the procedure for locating the menu/toolbar on the screen
- D. Discuss the procedure for locating and setting the properties of the command line

V. Discuss the Procedure for Setting the Various File Locations Necessary for Cad to Operate Properly Including:
- A. Menu file locations
- B. Drawing file locations
- C. Support file locations
- D. Printer driver locations
- E. Other file locations

VI. Discuss the Procedure for Setting the Object Snap Features

VII. Discuss the Procedure for Setting the Print/Plot Functions of CAD

VIII. Discuss the Procedure for Setting the Text Style

IX. Discuss the Procedure for Setting the Primary Units for a CAD Drawing
- A. Discuss the type of units to use:
  1. Decimal (e.g., 15.30)
  2. Scientific (e.g., 1.530 E+10)
  3. Engineering (e.g., 15' 6")
  4. Architectural (e.g., 15'-6 ½")
- B. Discuss the setting of the accuracy of the units:
  1. Number of decimal places
  2. Smallest fractional unit

X. Discuss the Procedure for Setting the Menu/Toolbar
- A. Discuss the procedure for selecting the specific menu to load
- B. Discuss the procedure for selecting the specific toolbars to load
- C. Discuss the procedure for setting the location of the menu and toolbars

CAD-F5-LE
Utilize Drawing Setup Procedures
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Demonstrate skills necessary for achieving educational objectives.

CAD-F6-HO
Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Construct objects;
- b. Edit objects; and,
- c. Manipulate objects.

Module Outline:

- I. Discuss Input Methods Used with Geometric Construction Commands
    - A. Discuss use of coordinate points to locate geometry in two-dimensional space
        - 1. Use rectangular (Cartesian) coordinate points – (X,Y)
            - a. Use absolute coordinate values – relative to origin (0,0)
            - b. Use relative coordinate values – coordinate values relative to previous coordinate pair
        - 2. Use polar coordinate points – (R, θ)
            - a. Use absolute coordinate values – relative to origin (0,0)
            - b. Use relative coordinate values – coordinate values relative to previous coordinate pair
    - B. Discuss procedure for using input devices
        - 1. Demonstrate "picking" method – using input device to specify coordinate points in the drawing area on the screen
            - a. Use mouse button to pick coordinate values on the screen
            - b. Use keyboard to type the coordinate values
        - 2. Demonstrate "entry" method – using input device to enter the command and have the computer generate the required geometry in the drawing area on the screen
            - a. Use mouse button
            - b. Use keyboard button
        - 3. Demonstrate "exit" method – method used to "exit" the command before proceeding to the next command
    - C. Discuss method for selecting a command
        - 1. Demonstrate the procedure for picking the command from the menu area
        - 2. Demonstrate the procedure for typing the command
        - 3. Demonstrate the procedure for picking the command from the toolbar
- II. Discuss Geometric Construction Commands

- A. Demonstrate the procedure for using the POINT construction command (or its equivalent)
- B. Demonstrate the procedure for using the LINE construction command (or its equivalent)
- C. Demonstrate the procedure for using the CIRCLE construction commands (or their equivalent)
- D. Demonstrate the procedure for using the ELLIPSE construction commands (or their equivalent)
- E. Demonstrate the procedure for using the ARC construction commands (or their equivalent)
- F. Demonstrate the procedure for using the SPLINE construction command (or its equivalent)
- G. Demonstrate the procedure for using the POLYLINE construction command (or its equivalent)
- H. Demonstrate the procedure for using the POLYGON construction command (or its equivalent)

III. Discuss Commands Used to Edit Geometric Objects

- A. Demonstrate the procedure for selecting objects (creating a selection set)
  - 1. Picking objects with mouse
  - 2. Picking objects with keyboard commands
    - a. Last object
    - b. All objects
  - 3. Picking objects with a window
    - a. Window
    - b. Crossing window
- B. Demonstrate the procedure for removing objects from the selection set
- C. Demonstrate the procedure for using the ERASE command (or its equivalent)
- D. Demonstrate the procedure for using the TRIM command (or its equivalent)
- E. Demonstrate the procedure for using the EXTEND command (or its equivalent)
- F. Demonstrate the procedure for using the BREAK command (or its equivalent)

IV. Discuss Commands Used to Manipulate Geometric Objects

- A. Demonstrate the procedure for using the COPY command (or its equivalent)
- B. Demonstrate the procedure for using the MOVE command (or its equivalent)
- C. Demonstrate the procedure for using the SCALE command (or its equivalent)
- D. Demonstrate the procedure for using the OFFSET command (or its equivalent)

E. Demonstrate the procedure for using the ROTATE command (or its equivalent)
F. Demonstrate the procedure for using the MIRROR command (or its equivalent)
G. Demonstrate the procedure for using the ARRAY command (or its equivalent)
H. Demonstrate the procedure for using the LENGTHEN command (or its equivalent)

CAD-F6-LE
Use Geometric Objects (e.g., Lines, Splines, Circles, etc.)
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings incorporating all discussed commands. The complexity of the drawing should increase progressively, beginning with the most basic drawing which incorporates the most basic geometric construction and editing commands.

CAD-F7-HO
Use Text for Drawing Annotation
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
a. Create text annotation; and,
b. Edit text.

Module Outline:

I. Discuss Procedure for Executing the TEXT Command (or its Equivalent)
  A. Demonstrate method for executing TEXT command from menu
  B. Demonstrate method for executing TEXT command from toolbar
  C. Demonstrate method for executing TEXT command by typing
II. Discuss TEXT Command Options
  A. Discuss text starting point specification: coordinate point
  B. Discuss text alignment and justification:
    1. Justification: Align / Fit / Center / Middle / Right / TL / TC / TR / ML / MC / MR / BL / BC / BR
    2. Alignment: vertical, horizontal, rotated
III. Discuss Commands Used to Edit Text:
  A. DDEDIT command – allows the text string to be changed
  B. MODIFY PROPERTIES (select text) – allows all of the text properties to be changed (text string, starting point, text style, justification, alignment, layer, color, linetype, etc.)
IV. Discuss STYLE Command
  A. The STYLE command allows the CAD operator to change the text font.
  B. Standard style for mechanical drawings – Roman Simplex (romans)

CAD-F7-LE
Use Text for Drawing Annotation
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create drawings which allows the student to create and modify text.

CAD-F8-HO
Use Viewing/Display Commands
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Demonstrate view commands;
- b. Create multiple viewing windows; and,
- c. Demonstrate 3D display procedures.

Module Outline:

- I. Identify the Basic Viewing Commands: ZOOM and PAN
  - A. Discuss the ZOOM command
    - 1. Define what the ZOOM command does
    - 2. Discuss the command options (All/Center/Dynamic/Extents/Previous/Scale(X/XP)/Window/Real time)
    - 3. Demonstrate the procedure for using the ZOOM command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
  - B. Discuss the PAN command
    - 1. Define what the PAN command does
    - 2. Discuss the command options (Realtime/Point/Left/Right/Up/Down)
    - 3. Demonstrate the procedure for using the PAN command
      - a) Show function of command options
      - b) Use mouse and keyboard for command input
- II. Discuss TILED VIEWPORT (VIEWPORTS) Command
  - A. Discuss the use of TILED VIEWPORTS in Model Space
  - B. Demonstrate the procedure for applying multiple viewports to the drawing area
  - C. Demonstrate procedure for saving/restoring viewports
- III. Discuss 3D Viewing Commands
  - A. Discuss parameters for 3D viewing
    - 1. Discuss 3D coordinate system
      - a. User Coordinate System (UCS)
      - b. World Coordinate System (WCS)
    - 2. Discuss coordinate location of observer
    - 3. Discuss coordinate location of object to be viewed
  - B. Discuss limitations of 3D viewing
    - 1. Can only draw on X-Y plane (at Z=0) as defined by the WCS
    - 2. Difficulty/confusion in drawing in 3D

    - 3. Difficulty/confusion in viewing 3D objects
  - C. Demonstrate VPOINT command
    - 1. Demonstrate coordinate entry method
    - 2. Demonstrate preset viewing positions
    - 3. Demonstrate use of Viewing Tripod
  - D. Discuss use of TILED VIEWPORTS for 3D viewing
    - 1. Orthographic views
      - a. Preset views
      - b. Using VPOINT command to specify orthographic views
    - 2. Setup for simulated orthographic views: top, front, right-side, etc.
- IV. Discuss Saving Views
  - A. Demonstrate the VIEW command for saving views
  - B. Demonstrate the VIEW command for retrieving views

CAD-F8-LE
Use Viewing/Display Commands
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) The instructor should demonstrate the above commands on a variety of drawings. No assignments are to be given to specifically test whether the various view commands are being used properly by the students. However, when the students are working on more complex drawings in later assignments, they must be able to perform various viewing operations.

CAD-F9-HO
Control Object Properties
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Determine object property; and,

b. Modify object property.

Module Outline:

I. Discuss Object Properties
   A. Define object property: visual and geometric of a graphical object (line, circle, text).
   B. Discuss general properties:
      1. Color
      2. Layer
      3. Linetype
   C. Discuss object-specific properties:
      1. Geometric data (e.g., starting point, ending point, radius, etc.)
      2. Style (e.g., text style, dimension style, etc.)
      3. Miscellaneous (linetype scale, block, insertion point, etc.)

II. Discuss Procedure for Displaying Object Properties
   A. Demonstrate the use of the Modify Properties command
   B. Demonstrate the use of the LIST command

III. Discuss Procedure for Modifying Object Properties
   A. Demonstrate the use of the Modify Properties command
   B. Discuss special property modifying commands (modify text, modify hatch, modify dimension, modify polyline, modify spline, modify multiline)
   C. Demonstrate the procedure for using the Match Properties command

CAD-F9-LE
Control Object Properties
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) **Answer review questions; and,**

b) **Create drawings using various drawing objects (lines, circle, text, etc.). Students must then modify the properties of the objects according to given specifications.**

CAD-F10-HO
Understand Procedure to Print/Plot a Drawing
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Demonstrate plotting procedure;
- b. Determine scaling and layout; and,
- c. Use various printers and plotters.

Module Outline:

- I. Discuss Important Printing Factors
  - A. Define drawing scale: the resultant scale at which the drawing is printed. CAD drawings are always drawn at full scale; they are scaled up or down at the printing stage.
  - B. Discuss how to control the thickness of the plotted lines
    - 1. The thickness of the plotted lines is controlled by the color of the lines as they appear in the CAD drawing.
    - 2. The color of the lines in the CAD drawing is typically controlled by the layer on which the drawing object resides (e.g., the VISIBLE layer is yellow, therefore all the lines drawn on that layer are yellow and they will plot with the thickness that is assigned to the color yellow.)
    - 3. The pen thickness setting is used to specify the width of the plotted lines
  - C. Discuss how to select the plotted paper size
    - 1. Directly related to the plotted drawing scale and the size of the drawing
    - 2. Use standard drawing sheet sizes (see CAD-B1: Use Drawing Media and Related Drafting Materials)
- II. Discuss the Procedure for Printing a Drawing
  - A. Demonstrate the procedure for selecting the PRINT command
  - B. Discuss the features of the Print Dialog Box
    - 1. ***Device selection:*** demonstrate the procedure for selecting a printer or plotter
    - 2. ***Pen parameters:*** demonstrate the procedure for assigning a pen to a color and specifying the width of the pen
    - 3. Demonstrate the procedure for specifying the type of view to be plotted
      - a. Extents: plot all drawing objects
      - b. Window: specify a rectangular window which will define the plotting area

    c. Display: plot the drawing as shown in the current drawing view
    d. Limits: the area to plot is specified by the prescribed limits of the drawing, set with the LIMITS command.
4. *Paper size:* demonstrate the procedure for selecting the desired paper size measured in appropriate units (inches or millimeters)
5. Demonstrate the procedure for specifying the desired plotting scale and orientation
    a. Specify the plotted scale according to the formula [plotted units] = [drawing units] (e.g., 1=2 scale (half scale) corresponds to 1 inch measured on the plotted drawing is equal to 2 inches measured in the CAD drawing)
    b. Specify the plot rotation: how the plotted drawing will be rotate on the paper
    c. Specify the origin of the plot: specify the location of the origin (0,0) in the CAD drawing on the plotted drawing.
6. Demonstrate the procedure for viewing a plot preview
7. Demonstrate the procedure for plotting to a file

CAD-F10-LE
Understand Procedure to Print/Plot a Drawing
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Plot various drawings using given plot settings, such as plot scale, viewing area, paper size, etc.

CAD-F11-HO
Use Standard Layering Techniques
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:
- a. Define standard layering procedures; and,
- b. Apply standard layering techniques.

Module Outline:

- I. Define Layers: Named Groups of Graphical Objects Which Can Be Set to Have the Same Color and Linetype Property
  - A. Layers can be turned on or off in order to show or hide the objects on that layer
  - B. The color and linetype properties of the objects on a layer can be modified with a single command
  - C. The current layer is the layer that newly created objects will be placed on
- II. Discuss Standard Usage of Layers in CAD
  - A. Objects typically grouped according to standard linetypes used in mechanical drafting
    - 1. All hidden lines are placed on the "Hidden" layer
    - 2. All visible lines (continuous lines) are placed on the "Visible" layer
    - 3. All center lines are placed on the "Center" layer
    - 4. All phantom lines are placed on the "Cutting-Plane" layer
  - B. Layer groups also include to special objects
    - 1. All section lines (continuous lines) are placed on the "Section" layer
    - 2. All dimension lines (continuous lines) are placed on the "Dimension" layer
    - 3. All text (continuous lines) is placed on the "Text" layer
    - 4. The title block and border is placed on the "Title-block" layer
  - C. Additional grouping for assembly drawings according to object type (e.g., all bolts are placed on the "Bolts" layer, all gears are placed on the "Gear" layer, etc.)
  - D. Layer names should correspond to some feature of the objects residing on the layer
  - E. Maintain same color/linetype specifications on layer (e.g., do not place red lines on the "Visible" layer set to the color yellow)
  - F. Additional objects or features that do not fall into a pre-made layer should be placed on a new layer

III. Demonstrate the LAYER Command
    A. Demonstrate the procedure for creating a new layer
    B. Demonstrate the procedure for modifying an existing layer
        1. Changing the color
        2. Changing the linetype
    C. Demonstrate the procedure for controlling the visibility of the layer
        1. Freeze or thaw the layer
        2. Turn on or off the layer
    D. Demonstrate the procedure for changing the current layer

IV. Demonstrate Other Commands Associated with Layers
    A. Demonstrate the MATCH PROPERTIES command: change the properties (including the layer) of a selected set of objects to match the properties of another object
    B. Demonstrate the MODIFY PROPERTIES command: change the layer of a selected group of objects
    C. The BYLAYER property used as the color or linetype for an object specifies that that objects' color and linetype is set according to the layer on which it resides

CAD-F11-LE
Use Standard Layering Techniques
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;
b) Create drawings with multiple layers;
c) Change objects from one layer to another;
d) Change the properties of the layers;
e) Create new layers; and,
f) Use layers according to standard layer usage rules.

CAD-F12-HO
Create Mechanical CAD Drawings
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Use CAD to create multi-view orthographic drawings; and,
- b. Understand 2D multi-view drawing procedures on CAD system.

Module Outline:

- I. Discuss Orthographic Projection in CAD
  - A. Demonstrate procedure for maintaining alignment between views
    - 1. Use line projected horizontally or vertically to line-up adjacent views
    - 2. Extend boundary edges of object in one view to adjacent views
    - 3. Construct miter line for adjacent views that do not share a fold line (e.g., top and right-side view)
  - B. Demonstrate procedure for creating a new orthographic view from an existing orthographic view
    - 1. Demonstrate procedure for creating a regular orthographic view
      - a. Project/draw lines from existing views perpendicularly through fold line
      - b. Establish reference plane/surface
        - (1) Use fold line as reference plane/surface
        - (2) Use OFFSET command to create reference plane/surface
        - (3) Use coordinate drawing to create reference plane/surface
      - c. Begin drawing new view using measurements based on reference plane/surface
        - (1) Use OFFSET command to create lines from reference plane/surface
        - (2) Use coordinate entry to create lines from reference plane/surface
    - 2. Demonstrate procedure for creating an auxiliary view
      - a. Draw auxiliary fold line parallel to inclined surface (surface to be projected in the auxiliary view)
        - (1) Use COPY command to create parallel copy of inclined surface
        - (2) Use OFFSET command to create parallel copy of inclined surface
      - b. Project lines perpendicularly through auxiliary fold line

- (1) Use EXTEND command to project line to fold line
- (2) Draw lines using PERPENDICULAR OBJECT SNAP and "snapping" perpendicular to fold line
- c. Establish reference plane/surface
  - (1) Use fold line as reference plane/surface
  - (2) Use OFFSET command to create reference plane/surface
  - (3) Use coordinate drawing to create reference plane/surface
- d. Begin drawing new view using measurements based on reference plane/surface
  - (1) Use OFFSET command to create lines from reference plane/surface
  - (2) Use coordinate entry to create lines from reference plane/surface

- II. Discuss Drawing Layout in CAD
  - A. Demonstrate procedure for drawing title block and border
    - 1. Determine sufficient paper size for drawing (use ANSI or ISO standard sizes)
      - a. Use ANSI inch sizes for drawings in inches
      - b. Use ISO millimeter sizes for metric drawings (drawn in millimeters)
    - 2. Draw rectangular border one inch inset from paper border on all sides (e.g., if paper size is 17"x11" then border size is 15"x9")
    - 3. Determine title block layout (see mechanical drawing textbook for acceptable sizes, shapes, and layouts)
  - B. Demonstrate procedure for centering the drawing within the border
    - 1. Set distances between views
      - a. Allow for dimensions if applicable
      - b. Allow for labels if applicable
    - 2. Determine maximum distances in each view (distances parallel to border edges)
      - a. Maximum length and height in front and back views
      - b. Maximum height and width in side views
      - c. Maximum width and length in top and bottom views
      - d. Determine maximum dimensions, measured parallel to border edges, of auxiliary views
    - 3. Determine usable area in border (allow for title block and notes)
    - 4. Compute distance from edge of border to edge of views using distances determined above
    - 5. Adjust layout of views to accommodate discrepancies or irregularities

CAD-F12-LE
Create Mechanical CAD Drawings
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Create mechanical drawings. Drawings should progress through difficulty from relatively simple geometry to more complex geometry.

CAD-F13-HO
Create 3D Mechanical Models
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Convert 2D drawing information into 3D;
- b. Create and edit wireframe model;
- c. Create and edit 3D surface model; and,
- d. Create and edit 3D solid model.

Module Outline:

- I. Discuss Dimensions (2D) in Orthographic Projection
  - A. Discuss the dimensions in each orthographic view (standard views)
    - 1. Demonstrate how front and back views show height and length dimensions
    - 2. Demonstrate how top and bottom views show length and width dimensions
    - 3. Demonstrate how side views show width and height dimensions
  - B. Discuss the duplication of dimensions between views
    - 1. Demonstrate the "common measurement rule"
- II. Discuss Applying Dimensions from Orthographic Views to 3D Models
  - A. Determine how dimensions correlate to 3D axis (X, Y, Z)
    - 1. Width dimensions parallel to Y axis
    - 2. Length dimensions parallel to X axis
    - 3. Height dimensions parallel to Z axis
  - B. Discuss orientation of 3D coordinate axis
    - 1. Z axis is normal to computer screen in "2D" drawings, the X-axis is horizontal and positive to the right, and the Y-axis is vertical and positive upwards
    - 2. In 3D drawings, the height dimensions are in the positive direction of the Z axis
    - 3. Use "right-hand rule" for orienting 3D axis in space
- III. Discuss 3D Viewing Techniques
  - A. Discuss setting multiple views in the drawing area
    - 1. Demonstrate the procedure for setting an orthographic view (top, front, side view)
    - 2. Demonstrate the procedure for setting an isometric view
  - B. Demonstrate the procedure for using a selected view to aid in reorienting the UCS
- IV. Discuss 3D Line Drawing in CAD
  - A. Discuss the 2D drawing plane

1. CAD only allows drawing parallel to the X-Y plane of the User Coordinate System (UCS) at the current elevation (Z value)
    a. Discuss how the World Coordinate System (WCS) cannot be modified
    b. Demonstrate how to use the UCS command to manipulate the User Coordinate System to reorient the X-Y plane to the proper plane for drawing
2. Demonstrate how to use the ELEVATION command to change the Z value
3. Discuss special cases:
    a. Point-to-point drawing can be done no matter the orientation of the X-Y plane
    b. 2D shapes (circles, polygons, etc.) are always oriented parallel to the X-Y plane

B. Discuss 3D wireframe drawing
1. Define *wireframe:* a 3D drawing using only 1D objects, such as lines and circles. A drawing of an object constructed of "wires".
2. Demonstrate the procedure for creating 3D wireframe drawing
    a. Use UCS command to change UCS to reorient the X-Y plane
    b. Use COPY command to quickly draw repetitive features
    c. Use OBJECT SNAP to "snap" to geometric points on the objects
3. Demonstrate the procedure for setting 3D views of wireframe object
    a. Use multiple viewports to view object from different vantage points
    b. Set multiple viewports as orthographic views

V. Discuss Surface Modeling in CAD

A. Define surface: a 2D shape lacking thickness, typically planar although special non-planar shapes can be constructed

B. Define surface model: a 3D object made up of 2D surfaces and lacking a solid volume (hollow)

C. Discuss surface modeling commands:
1. Demonstrate the procedure for creating a 3D face
2. Demonstrate the procedure for creating a revolved surface
3. Demonstrate the procedure for creating a tabulated (mesh) surface
4. Demonstrate the procedure for creating a ruled surface
5. Demonstrate the procedure for creating an edge surface

D. Demonstrate the procedure for creating a surface model
1. Use UCS command to reorient the X-Y plane
2. Use wireframe model/lines for locating surfaces endpoints
3. Use 3D edit commands to modify surface model

        a. Demonstrate 3D rotate command
        b. Demonstrate 3D mirror command
        c. Demonstrate 3D array command

VI. Discuss Solid Modeling in CAD
  A. Define solid model: a 3D object with a solid volume
  B. Discuss techniques used to create and edit solid models
    1. Define Boolean construction: construction of 3D solid shapes from two separate solid objects using logical operations, such as UNION, SUBTRACT, INTERSECT
    2. Define Primitive: one of six basic 3D solid shapes (sphere, box, cylinder, torus, wedge, cone, pyramid)
    3. Demonstrate the procedure for creating a 3D solid primitive
        a. Demonstrate the procedure for using the
    4. Demonstrate the procedure for orienting a 3D solid object 3D space
        a. Use the MOVE command
        b. Use the COPY command
        c. Use the 3D rotate command
        d. Use the 3D mirror command
        e. Use the 3D array command
    5. Demonstrate the procedure for using Boolean operations
        a. Demonstrate the UNION command
        b. Demonstrate the SUBTRACT command
        c. Demonstrate the INTERSECT command

CAD-F13-LE
Create 3D Mechanical Models
Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create 3D wireframe models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry;

c) Create 3D surface models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry; and,

d) Create 3D solid models of mechanical objects. Drawings should progress from relatively simple geometry to more complex geometry.

CAD-F14-HO
Use Drawing Feature Attributes
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify attribute data;
b. Apply attribute data; and,
c. Extract attribute data.

Module Outline:

- I. Define and Discuss Attributes
  - A. Definition: an attribute is an interactive label attached to a block of drawing objects
  - B. Discuss uses for attributes
    - 1. Parts list
    - 2. Bill of materials
    - 3. Price list
  - C. Discuss requirements for use of attributes
    - 1. Object must be a block
    - 2. Define attributes for the block
    - 3. Text file reader for post-processing of extracted attribute data
- II. Discuss Creation of Attributes
  - A. Demonstrate the procedure for creating attribute definition (DDATTDEF command)
    - 1. Describe tag
    - 2. Describe prompt
    - 3. Describe value information
    - 4. Describe text formatting
    - 5. Describe location
    - 6. Describe optional definitions
  - B. Demonstrate the procedure for associating attribute with block definition
  - C. Demonstrate procedure for inserting block into drawing
  - D. Demonstrate the procedure for entering attribute data for specific block
- III. Discuss Extracting Data from an Attribute in a Drawing
  - A. Demonstrate the procedure for using the ATTEXT command
  - B. Discuss file format
    - 1. Comma Delimited File (CDF)
    - 2. Space Delimited File (SDF)
    - 3. Drawing Interchange File (DXF)

C. Discuss using a template file for extracting the data

D. Demonstrate the procedure for opening a text processing program (e.g., WORDPAD or NOTEPAD)

CAD-F14-LE
Use Drawing Feature Attributes
Attachment 2: **MASTER** Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Perform attribute operations on a drawing, including:
  (1) Defining the attributes;
  (2) Inserting the attributes;
  (3) Extracting the attribute information; and,
  (4) Performing a post analysis on the extracted attribute information.

CAD-F15-HO
Obtain 3D Model Property Data
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this unit the student will be able to:

a. Identify surface properties;
b. Extract surface properties;
c. Identify mass properties; and,
d. Extract mass properties.

Module Outline:

I. Define Surface Properties
  A. Coplanar and non-coplanar (2D) regions
    1. *Area:* the enclosed 2D space of a surface or region
    2. *Perimeter:* the total length of the inside and outside loops of a region
    3. *Bounding box:* the maximum coordinates that enclose the region
    4. *Centroid:* 2D or 3D coordinate that is the center of the area
  B. Coplanar (2D) regions: regions must be coplanar with the X-Y plane of the current UCS
    1. *Moment of inertia:* the area moment of inertia for regions
      a. (Moments of Inertia) = (area) x $(\text{radius})^2$ [units: distance^4]
    2. *Principal moments and directions about a centroid:* At the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.

II. Define Mass Properties (for 3D Solids)
  A. *Mass:* the measure of the inertia of a body. Computed from the density and volume of the solid.
  B. *Volume:* the total amount of 3D space that a solid occupies
  C. *Bounding box:* defined by the diagonally opposite corners of a 3D box that encloses the solid
  D. *Centroid:* a 3D point that is the center of mass for solids
  E. *Mass moments of inertia:* (Mass moment of inertia) = (mass) x $(\text{radius}_{\text{axis}})^2$ [units: mass x distance^2]

F. ***Products of inertia:*** (Product of inertia $_{YZ,XZ}$) = (mass) x (distance $_{\text{centroid to } YZ}$) x (distance $_{\text{centroid to } XZ}$) [units: mass x distance^2]

G. ***Radii of gyration:*** another way of indicating the moments of inertia of a solid.

  1. (Radii of gyration) = ((Moment of inertia)/(mass))^{½} [units: distance]

H. ***Principal moments and X,Y,Z mirections about a centroid:*** at the centroid of an object there is a certain axis through which the moment of inertia is highest. Another axis, normal to the first axis and also through the centroid, has about it a moment of inertia that is lowest. A third value included in the results is somewhere between the high and the low. These are the principal moments of inertia, which are derived from the products of inertia and have the same units.

III. Discuss the Method for Computing the Surface/Mass Properties

  A. Demonstrate the procedure for assigning a material type to the object (3D solids only)

    1. Material type determines the density
    2. AutoCAD version 14 uses a generic material with a density = 1 for all solids

  B. Demonstrate the procedure for using the MASSPROP command

  C. Demonstrate the procedure for writing property data to an external file

CAD-F15-LE
Obtain 3D Model Property Data
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must:

a) Answer review questions; and,

b) Perform mass/surface property calculations on a simple 3D object. Calculate the same properties manually and compare values. Compute the percent error.

CAD-F16-HO
Use CAD Dimensioning Features
Attachment 1: MASTER Handout

Objectives:

Upon completion of this unit the student will be able to:

- a. Identify dimensioning variables;
- b. Set dimensioning variables;
- c. Dimension drawings using CAD;
- d. Use dimensioning standards with CAD; and,
- e. Modify CAD dimensions.

Module Outline:

- I. Discuss Elements of Dimensions
  - A. Demonstrate and show extension lines
  - B. Demonstrate and show dimension lines
  - C. Demonstrate and show dimension text
  - D. Demonstrate and show arrowheads
  - E. Demonstrate and show leaders
  - F. Demonstrate and show standard dimension feature sizes (according to ANSI Y14.5M standards)
- II. Discuss Dimension Styles
  - A. Demonstrate the procedure for changing dimension styles
    - 1. Change geometry dimension styles
    - 2. Change format dimension styles
    - 3. Change annotation dimension styles
      - a. Demonstrate the procedure for altering the units
      - b. Demonstrate the procedure for creating tolerance symbols
      - c. Demonstrate the procedure for changing the dimension text style
  - B. Demonstrate the procedure for creating a dimension style
    - 1. Discuss parent/child dimension styles
    - 2. Create parent dimension style
    - 3. Create child dimension style
- III. Discuss the Application of Dimensions to a 2D Drawing
  - A. Demonstrate the procedure for setting/creating the dimension style
  - B. Demonstrate the procedure for setting object snap
  - C. Demonstrate the procedure for applying dimensions
    - 1. Apply linear dimensions
    - 2. Apply angular dimensions
    - 3. Apply leaders
    - 4. Apply radial/diametrical dimensions

    5. **Apply tolerance dimensions**
    6. **Apply geometric dimension codes**
    7. **Apply baseline dimensions**
    8. **Apply continuous dimensions**
    9. **Apply ordinate dimensions**

D. **Demonstrate the procedure for modifying an existing dimension**
    1. **Demonstrate the procedure for modifying the properties of a dimension**
    2. **Demonstrate the procedure for using the GRIPS command to modify dimensions**

CAD-F16-LE
Use CAD Dimensioning Features
Attachment 2: MASTER Laboratory Exercise

Students will be given classwork and homework assignments in which they must :

a) Answer review questions;

b) Create dimension style for standard, tolerance, and GDT dimensions in English (inches) and Metric (millimeters) units. Create parent and child relationships. Use ANSI Y14.5M standard as basis; and,.

c) Create mechanical drawings using orthographic projection. Apply dimensions to the drawing using proper CAD techniques and ANSI Y14.5M standards adherence.

CAD-F17-HO
Perform CAD Customization Procedures
Attachment 1: MASTER Handout

Objective(s):

Upon completion of this unit the student will be able to:

- a. Identify customization techniques and procedures; and,
- b. Use customization techniques and procedures.

Module Outline:

- I. Discuss Customization of Menus
  - A. Discuss using menu files
  - B. Discuss menu file structure
    - 1. Menu file group name
    - 2. Pointing-device button menu
    - 3. System pointing device menu
    - 4. Pull-down/cursor menu areas
    - 5. Toolbar definitions
    - 6. Image tile menu area
    - 7. Screen menu area
    - 8. Tablet menu area
    - 9. Accelerator key definitions
  - C. Demonstrate menu file editing
    - 1. Select editing program (e.g., Notepad)
    - 2. Demonstrate editing techniques
  - D. Discuss menu item syntax
  - E. Discuss loading menu files
    - 1. Demonstrate loading from CAD program
    - 2. Demonstrate the procedure for loading at startup
    - 3. Demonstrate for loading multiple menus
- II. Discuss Customization of Toolbars
  - A. Demonstrate the procedure for customizing a toolbar
  - B. Demonstrate the procedure for creating anew toolbar
  - C. Demonstrate the procedure for creating toolbar button graphics
  - D. Discuss loading custom toolbar files
- III. Discuss Creating Profiles
  - A. Demonstrate customizing the display
    - 1. Demonstrate setting the display color
    - 2. Demonstrate setting the display fonts
    - 3. Demonstrate setting the general display options
  - B. Demonstrate customizing the pointer device
  - C. Discuss setting the file locations

IV. Discuss Creating a Drawing Template
    A. Demonstrate setting the layers
    B. Demonstrate setting the dimension styles
    C. Discuss including special blocks (internal)
    D. Demonstrate including/creating linetypes
V. Discuss Creating Command Aliases (Shortcut Command Syntax Used for Commonly Executed Commands)
VI. Discuss Customizing the Printer Configuration
    A. Demonstrate setting the printers
    B. Demonstrate setting the plot settings (rotation, plot origin, paper sizes, etc.)

CAD-F17-HO
Perform CAD Customization Procedures
Attachment 1: MASTER Handout

Students will be given classwork and homework assignments in which they must:

a) Answer review questions;

b) Create dimension style for standard, tolerance, and GDT dimensions in English (inches) and Metric (millimeters) units. Create parent and child relationships. Use ANSI Y14.5M standard as basis; and,

c) Create mechanical drawings using orthographic projection. Apply dimensions to the drawing using proper CAD techniques and ANSI Y14.5M standards adherence.